# DOCUMENT RESUME

ED 285 776 SE 048 365

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|---|---|
| TITLE | General Science, Ninth Grade: Theme III and Theme IV. Experimental. |
| INSTITUTION | New York City Board of Education, Brooklyn, N.Y. Div. of Curriculum and Instruction. |
| REPORT NO | CURRIC-00-8040-91; ISBN-88315-565-6 |
| PUB DATE | 84 |
| NOTE | 309p.; For the student laboratory manual, see SE 048 366. For Theme I and Theme II manuals, see SE 014 363-364. |
| AVAILABLE FROM | New York City Board of Education, Division of Curriculum & Instruction, 131 Livingston St., Room 613, Brooklyn, NY, 11201 ($15.00). |
| PUB TYPE | Guides - Classroom Use - Guides (For Teachers) (052) |
| EDRS PRICE | MF01 Plus Postage. PC Not Available from EDRS. |
| DESCRIPTORS | Diseases; *Environmental Education; *General Science; *Grade 9; Hazardous Materials; Pollution; Science Activities; Science and Society; Science Curriculum; Science Education; Science Instruction; Secondary Education; *Secondary School Science; Water; Water Treatment |
| IDENTIFIERS | *New York City Board of Education |

ABSTRACT

This document was designed to help teachers provide ninth grade students in New York City with opportunities to learn about scientific processes as well as basic reasoning skills which underlie problem-solving processes in scientific and nonscientific disciplines. The first section of the guide, "The Environment," contains lessons which deal with soil, hazardous wastes, wildlife refuges, the water cycle, water treatment, acid rain, basic concepts about air, air pollution, environmental careers, and individual environmental responsibilities. Section two, "Health and Diseasd," contains activities on the topics of infectious and noninfectious diseases, natural defenses against disease, the identification of new diseases, and health related careers. At the end of each unit is a list of review questions. Also included is a bibliography for students, a list of government sources for further information, selected teacher references, a list of filmstrips, some suggested field trips, and a survey form for the teacher's evaluation of the curriculum materials. (TW)

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# GENERAL SCIENCE

Experimental

ED285776

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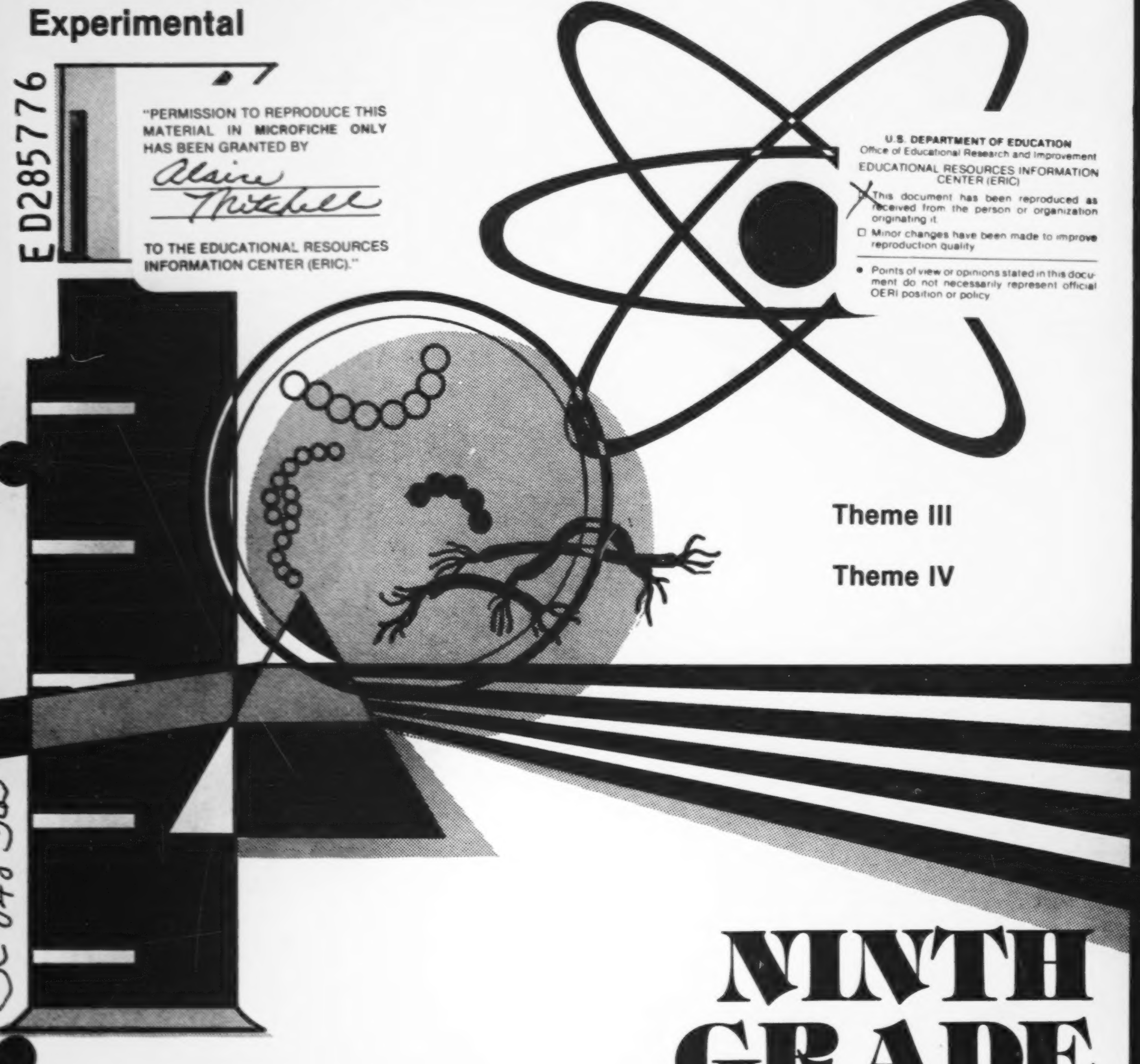

Theme III

Theme IV

SE 048 365

# NINTH GRADE

ISBN 88315-565-6
CURRIC. NO. 00-8040-91

NEW YORK CITY BOARD OF EDUCATION
Office of Curriculum Development and Support
Division of Curriculum and Instruction

BEST COPY AVAILABLE

ISBN 88315-565-6 CURRIC. NO. 00-8040-91

Copies of this publication may be obtained from the Curriculum Production Unit, Room 613, 131 Livingston Street, Brooklyn, New York 11201. See current catalogue for price.

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# FOREWORD

In our technologically oriented society, students need to acquire scientific literacy. To meet this goal, Ninth Grade General Science has been designed to help New York City students learn about the scientific process as well as basic science concepts. In addition, the curriculum emphasizes basic reasoning skills which underlie problem-solving processes in scientific and nonscientific disciplines. In the lessons in this guide, students are encouraged to:

- make hypotheses
- plan, design, and implement investigations
- collect, plot, chart, and interpret data
- explore in depth topics of common concern, such as placement of nuclear power plants
- make decisions based on evidence rather than supposition or emotion
- discuss careers that are related to the scientific enterprise
- understand the need for controlled experiments
- recognize the need to modify hypotheses on the basis of new evidence

The lessons in this guide have been prepared as models for the inexperienced teacher and as points of departure for the experienced teacher. It is not our aim that all teachers in all classes teach the material the same way, or even in the same sequence. These lesson guides represent a synthesis of several points of view, and represent one way in which the objectives of the general science curriculum can be implemented. For example, teachers will think of motivations which are more suited to their own classes and teaching styles and they will develop concepts different from the models in this guide.

We request that all teachers who teach Ninth Grade General Science complete the questionnaire included at the back of each guide and return it to the Science Unit as soon as they finish teaching the course.

We hope this guide will serve to stimulate teachers to think more about general science and its role in helping students to develop scientific literacy.

Charlotte Frank

Charlotte Frank
Executive Director
Division of Curriculum and Instruction

# ACKNOWLEDGMENTS

The present adaptation of the ninth grade course of study in general science is the outgrowth of several years of work by many individuals. It is a project of the Division of Curriculum and Instruction, Charlotte Frank, Executive Director, and the Office of Curriculum Development and Support, Morris Freedman, Director. The curriculum was produced under the supervision of Anthony Galitsis, Director of Science.

Begun in 1979 by a group of science teachers and supervisors who wanted to delineate more precisely those skills and concepts that students should possess in order to be successful in high school biology, the first draft appeared as the experimental edition of the Minimum Learning Essentials in the Spring of 1981. Feedback from numerous individuals, analysis of student test results in January 1982, and comments from teachers who taught courses of study based directly upon the first draft, were analyzed with a view toward revising the Minimum Learning Essentials to provide a complete course of study that would at once both stimulate and absorb the urban ninth grade student. Throughout, the goals of the original writing committee were kept in mind.

In July 1982, a writing team consisting of Jordan Shein (Jamaica HS), Jane Weiss (Forest Hills HS), Mary DiBlasio (FDR HS), Audrey Saltsberg (JHS 218Q), Simon Fenster (Mable Dean Bacon HS), Harold Alper (South Shore HS), and Audrey Baden (Flushing HS, representing the Division of Special Education), met to plan the translation of the Minimum Learning Essentials into the program found in this present volume. Under the supervision and direction of Dr. Galitsis, the writers investigated the curricula of many cities and states throughout the United States. The end result was a decision to produce a course of study made up of four complementary themes, as opposed to a course of study based on the usual division of the course into the usual "four sciences," biology, chemistry, physics, and earth science.

The committee felt that science today is best approached through a "unified" approach: the melding of all the sciences in an attempt to understand those problems that occupy the minds of most scientifically literate citizens today: namely energy, disease, and the environment. By September 1982 the first half of the new course of study was ready for trial in the schools. Albert Tarendash (Stuyvesant HS), reviewed and edited the trial manuscript in August of 1982. Volunteers were solicited to teach the lessons and comment on their merits. Sallejane Seif of the Division of Special Education provided assistance in locating teachers of special education to field-test the new curriculum. All together more than 50 teachers field-tested all or parts of the new course, and provided valuable feedback.

In the Spring of 1983, Eugene McCoy (Martin Luther King, Jr. HS) and John Bruno (High School of Music and Art) were asked to collate all of the feedback received from the teachers field-testing the curriculum. Their report was presented to the writing team, which now consisted of Joel Beller (Francis Lewis HS), Donald Abramson (Martin Van Buren HS), Audrey Saltsberg and Audrey Baden. John Kominski, Assistant Director of Science, supervised the writing team during the writing of the last half of the curriculum. The committee decided to call together teachers who were field-testing the curriculum to make specific suggestions for revising the course. Two such meetings took place during May 1983, and the suggestions received from the participants formed the basis for the revision that was to follow.

During the summer of 1983, a revision committee consisting of Audrey Saltsberg, Michael Perlman (Jamaica HS), and Carol Izzo (Grover Cleveland HS) began work on the final draft of the curriculum, and finished it in August of that same summer.

Throughout the school year 1982-83, the material was reviewed and edited by Sidney Harris (John Bowne HS, retired) and Anthony Galitsis, who each introduced many "Notes to the Teacher" throughout the course guide to provide background information and helpful hints to the teacher.

Additional feedback and suggestions were received during the 1983-1984 school year. These suggestions were incorporated into this final revision in the spring of 1984 by Harold Friend (JHS 25Q) and Joel Beller (Francis Lewis HS).

Special lessons on decision making were contributed by Jay Kahn (JHS 234B) and Juliet Simms (Morris HS) and incorporated into the final revision.

The following teachers and supervisors, not mentioned above, deserve special mention for their willingness to travel into uncharted waters by field-testing and evaluating the curriculum in its formative stages. Without their feedback and determination to stick it out, even though they did not know what they would be teaching for more than four or five weeks at a time, it would not have been possible to present this course of study in its present form.

Teachers involved in pilot-testing Ninth Grade General Science curriculum and who returned completed evaluations forms are Maria Allan Capoti, Herbert H. Lehman HS; Harold Alper, South Shore HS; Audrey Badin, Flushing HS; Joel Beller, Francis Lewis HS; David Brown, Francis Lewis HS; John Bruno, Music and Art HS; T. Campo, John F. Kennedy HS; Joyce Chester, Martin Luther King, Jr., HS; Frank DeFelice, Jamaica HS; R. Effinger, Herbert H. Lehman HS; Steven Farbstein, Jamaica HS; Julia Garcia, Alfred E. Smith HS; Fred Isaacs, Alfred E. Smith HS; Clifford J. Jensen, Boys and Girls HS; Larry Kahn, Martin Van Buren HS; Andrea Kanner, Francis Lewis HS; Michele Kearse, Far Rockaway HS; Gerald Macmillian, Thomas Jefferson HS; Barry Malloy, Martin Luther King, Jr.

HS; E. Marzano, Edward R. Murrow HS; Eugene McCoy, Martin Luther King, Jr., HS; Carl Mercellion, Grover Cleveland HS; J. Passariello, Lafayette HS; Marie Pellegrino, Bay Ridge HS; Michael Perlman, Jamaica HS; Dominick Perotta, Alfred E. Smith HS; Rita Pochter, Canarsie HS; Joseph Ryan, Susan E. Wagner HS; Rosemary Salerno, Sheepshead Bay HS; Audrey Saltsberg, JHS 217Q; Harvey Savoy, Boys and Girls HS; R. Schwartz, Eli Whitney HS; Elizabeth Scollon, Louis Brandeis HS; Jordan Shein, Jamaica HS; Francine Singer, Sheepshead Bay HS; Lucille Smith, Prospect Heights HS; W. Stolsi, John F. Kennedy HS; Anita Tavernier-Schmitt, Theodore Roosevelt HS; Margaret Villareal, Seward Park HS; Jane Weiss, Forest Hills HS; Sylvia Weperin, Jamaica HS; Elaine Wilbon, August Martin HS; Michele Wolf, Music and Art HS.

The members of the feedback committee were Joyce Chester, David Brown, Audrey Saltsberg, Joel Beller, Andrea Kanner, Michael Perlman, Michele Wolf, John Bruno, Lucille Smith, Karren Izzo Karle, Jane Weiss. In addition, the help and cooperation of David Goldberg (Assistant Principal, JHS 296K) is gratefully acknowledged.

Special thanks are due to Anna Marie Parasole (Science Unit) for typing most of the manuscript.

The final manuscript was reviewed by Herbert Gottlieb (Martin Van Buren HS, retired) and was prepared for publication by the Curriculum Editorial and Production Unit, Alaire Mitchell, Unit Head. Peter Dews edited and supervised the production of the final manuscript. Steven Goodman and Judith Goldberg provided major editorial contributions. Maureen Maguire coordinated the printing and distribution. Artwork by Kent Beaty and Tom Wright. Cover design by John Gampert.

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# INTRODUCTION

Science can be both enjoyable and practical, and the Ninth Grade General Science curriculum has been written with this thought in mind. The lessons emphasize hands-on learning experiences, scientific processes, and the social, political, and moral implications of scientific issues.

Hands-on learning activities such as laboratory experiments allow students to participate in the processes of science. In this edition of the Ninth Grade General Science curriculum, hands-on activities are part and parcel of the lesson -- not just adjuncts to motivate or culminate lessons.

While not all students can or will become scientists, our technological society demands that students become literate in the basic sciences. Some science curricula assume that students have mastered the processes of science; this curriculum deliberately trains students in processes such as making hypotheses, observing and recording data, and drawing conclusions based on that data.

Ninth grade students are beginning to think about careers. To help students clarify their own thinking, the Ninth Grade General Science curriculum includes information about careers in the sciences.

It may once have been possible to think that science and its products existed in a vacuum, but that is no longer true. Our society is increasingly faced with critical issues--such as pollution control, biomedical engineering, and energy production--that require not only solutions to technical problems but decisions about society's priorities. The Ninth Grade General Science curriculum includes lessons that pose political and ethical questions involving scientific issues.

## Content

The Ninth Grade General Science curriculum draws from a variety of scientific disciplines and includes lessons on a range of scientific topics from measurement to light to health. These lessons not only introduce topics that are of importance to an educated person in our society, but serve as the springboard for the processes that are the focus of this curriculum.

The curriculum is organized into four themes. In Theme I students learn about laboratory equipment and procedures, scientific method, and basic skills of measurement. In Theme II they investigate various forms of energy and examine energy conservation and alternative sources of energy. In Theme III, students focus on environmental science, examining the past and present environments of the earth, studying pollution and its effects, and predicting the environment of the future. In Theme IV, students study disease and its relationship to cause and effect and to the scientific method. They examine the prevention and control of disease, the factors influencing longevity, and implications for the future.

Within each theme, units include several lessons that focus on a specific topic. All lessons have the same organization:

- a. Topic
- b. Suggested Aim
- c. Performance Objectives
- d, Motivation
- e. Development
- f. Summary
- g. Topics for Further Consideration (thought-provoking questions that can be used as a basis for homework.)

Many lessons include laboratory worksheets which are identical to those found in the student laboratory manual for this course.

PLEASE NOTE:

In the event that city-wide tests are developed for this course, the test items will be limited to Themes I, II, and III. Theme IV is considered to be an optional theme, and may be taught in part or in whole, or may be completely omitted by schools, depending on their particular circumstances. Teachers are encouraged to develop alternatives to Theme IV for use in their schools, and to share their lessons with the Science Unit.

We believe that by making Theme IV optional, we can provide schools with the flexibility to use the extra time in various ways: to spend more time on the difficult parts of the course; to teach more of the basic skills to students; or to develop lessons on topics of current interest such as astronomy, outdoor education, Halley's Comet, and so on.

## Implementation

We suggest that you read each unit in advance. As you plan the lessons for your own students, you will be able to draw on the suggested lessons, student worksheets, bibliography, and list of available audiovisual materials. Because there is yet no single textbook that parallels the topics in this curriculum exactly, you will need to select readings from a variety of sources based on the topics involved and the reading ability of your own students.

The following ideas may help you implement the curriculum more smoothly:

1. The first three weeks of the term involve a lot of laboratory work. Check the equipment available in your school against the materials suggested for use in the lab experiences.

2. To make sure you are familiar with the experiments and that students can do them safely, perform each demonstration and lab experience in advance.

3. Many of the lab experiences use equipment that is breakable and valuable. Discuss this with students as you talk with them about safety precautions and replacement procedures.

4. The ideal science classroom should have movable chairs and tables, running water, gas, and electrical outlets.

5. On one of the first days of class, organize students into lab groups of four students each. Give each group a number or name and assign a place in the classroom to work. Assign responsibilities to members of each lab group (captain -- picking up lab sheets and equipment, cleaning up, etc.) and set up a system to rotate the responsibilities.

6. For each lab experience there is a teacher's guide and a student worksheet. Reproduce additional copies of the student worksheet if they are needed. These may be completed for homework and brought to class for reading and discussion. It is a good idea to have the students maintain a looseleaf notebook or other binder in which marked lab sheets are permanently kept.

7. Have all students read the Introduction and Procedure sections of the worksheet before beginning each exercise. Be sure that students are clear about the purpose of the activity and that they understand the directions.

8. Putting the lab equipment on a tray such as a lunch tray or a similar tray will keep the equipment together and prevent liquids from spilling.

9. Use a variety of teaching methods with students and introduce study skills, such as directed reading, that will help students develop good study habits. Where appropriate, assign both reading and writing for homework so that students can develop their literacy skills.

10. Use the tests provided at the end of each unit or theme as another learning experience. Go over the students' answers, and find out why they missed certain items. This may lead you to reteach some points that caused difficulty.

11. In lessons where debates or panel discussions are called for, it is important that your views do not influence the students. Many of the issues presented in this syllabus have no answers acceptable to everyone. The important thing is to make sure that students understand the capabilities as well as the limitations of science. They must also realize that human values and politics often take precedence in making decisions dealing with science.

We hope you like this course of study. It represents the results of several years of work in which curricula from many cities and states were reviewed, and includes the most up-to-date thinking of science educators everywhere as to what science "should be."

We request that all teachers of Ninth Grade General Science complete the questionnaires included at the back of each of the two volumes of the guide and return them to the Science Unit, Division of Curriculum and Instruction, New York City Board of Education, 131 Livingston St., Brooklyn, NY 11201, as soon as they finish teaching the course.

# PERFORMANCE OBJECTIVES

Ninth Grade General Science is based on the philosophy that science teaching must incorporate, simultaneously, not only the content, but the processes of science as well. This imperative is reflected in the performance objectives outlined below.

This list of processes was developed by the Science Bureau of the New York State Education Department for use in their syllabi for grades 7-9. The mastery of these processes is as essential as the content to the mastery of the general science course of study.

Each of the content objectives which follows is keyed to one or more of the science process skills. For example, the first objective under Unit 1 is keyed to Processes [1], [4] and [6].

[1] Observing objects and phenomena
[2] Describing observations
[3] Selecting suitable measuring instruments
[4] Developing skills in using laboratory equipment
[5] Measuring objects and phenomena
[6] Performing laboratory techniques
[7] Estimating measurements within limits of accuracy
[8] Recognizing a problem
[9] Formulating a working hypothesis
[10] Designing appropriate tests of a hypothesis
[11] Designing suitable procedures for experimental tests
[12] Processing experimental data
[13] Organizing data to show a functional relationship
[14] Interpreting observations and data
[15] Interpolating and extrapolating
[16] Evaluating a hypothesis in the light of data obtained
[17] Formulating generalizations based on relationships
[18] Recognizing the need for a theoretical model
[19] Formulating a theoretical model to accommodate knowledge
[20] Designing relationships satisfied by a model
[21] Deducing a hypothesis from a theoretical model
[22] Interpreting and evaluating tests of a model
[23] Producing a revised, refined, or extended model

Numbers in brackets, [ ], following each objective are keyed to the Process Skills listed on the preceding page.

## THEME III: The Environment

### Unit 1: Soil

The students will be able to:

. State why soil is important to city residents. [1], [2]

. Explain how weathering occurs. [1], [2]

. Explain that weathering takes a long time. [1], [2]

. Relate the dependence of soil and living things on each other. [1], [2], [8]

. * Identify the composition of humus. [1], [2], [8]

. * Create a soil profile. [1], [2]

. Identify humus content as a factor in the water-holding capacity of a soil sample. [6], [8], [9], [10], [11], [16]

. Recognize the interrelationships between plants and soil. [1], [2]

. Recognize and describe the problems caused by disposal of garbage in landfills. [16], [17]

. Identify health problems associated with toxic waste disposal sites. [1], [16], [17]

### Unit 2: Water

The students will be able to:

. Understand the chemical structure of water. [1], [2]

. Explain that the water cycle involves the interaction of living and nonliving factors. [1], [2], [17]

. Explain why evaporation and condensation are important factors in the water cycle. [1], [2]

. Recognize the varied uses of water resources. [1], [2], [17]

. Explain the meaning of the water table and analyze reasons why the water table changes. [16], [17]

-- -- -- -- -- -- -- -- -- -- -- --

* Objectives preceeded by an asterisk (*) are optional and are not subject to examination.

- Identify types and sources of water pollution. [1], [2], [17]
- Identify an individual's role and/or responsibility in polluting water. [1], [17]
- * Explain the processes involved in water treatment. [1], [2], [17]
- Identify causes of acid rain. [2], [17]
- Describe the experimentation being done to counteract the effects of acid rain. [16], [17]
- * Analyze water to determine its mineral content. [2], [9], [10], [11], [12]

## Unit 3: Air

The students will be able to:

- * Explain that air is a mixture of gases. [2]
- * Explain the statement, "We live at the bottom of an ocean of air." [1], [17]
- * Demonstrate that air has weight. [4], [5], [6], [10], [11]
- List effects of air pollutants on the human body. [17]
- Describe ways of reducing air pollution caused by automobiles. [2], [8], [14]
- * Compare particulates found in laboratory experiments to samples of known solid pollutants from varied common sources. [1], [2], [6], [8], [17]
- Assess the relative pollution level of the air. [12], [13], [14], [19]
- State economic benefits of pollution control. [17]
- Identify occupations related to environmental work. [2]
- Assess the need to train more environmental technicians. [17]

---

* Objectives preceeded by an asterisk (*) are optional and are not subject to examination.

# THEME IV: Health and Disease

## Unit 1: Introduction to Health and Disease

The students will be able to:

- Identify the leading causes of death in the United States. [2]
- Categorize and differentiate between infectious and noninfectious diseases. [2], [17]
- Utilize a data table to construct a line graph and be able to draw conclusions from the graph. [12], [13], [14], [15]

## Unit 2: Noninfectious Disease

The students will be able to:

- Describe the symptoms of a heart attack. [2], [17]
- Relate the factors that contribute to the health of the circulatory system. [2], [17]
- Describe the current concern about the role of environmental agents and the causes of cancer. [2], [17]
- Contrast normal cells with abnormal cells typical of cancer. [1], [2], [17]
- List the early warning signs of cancer. [2], [17]
- Describe the importance of early detection. [1], [2]
- Identify methods for the treatment of cancer. [1], [2], [17]

## Unit 3: Infectious Disease

The students will be able to:

- Associate the environment with the presence of different microorganisms. [1], [2], [17]
- Relate disease to harmful microorganisms. [1], [2], [17]
- Identify pathways through which disease-producing organisms may enter the body. Give examples of organisms which enter through each pathway. [2], [17]
- Identify several methods by which disease-causing organisms are transmitted, including droplet infection, direct contact, and carriers. [2], [17]

- Identify the body's lines of defense against disease. [1], [2], [17]
- Identify chemical agents that break down the body's defenses against disease. [3], [4], [6]
- Perform procedures needed to culture bacteria. [4], [6], [14]
- List the conditions bacteria need for growth. [4], [6], [14]
- Identify the three main types of bacteria. [1], [3], [4]
- List materials and procedures that kill or retard the growth of bacteria. [4], [5], [6], [14], [17]
- Distinguish between natural, acquired, active and passive immunity. [1], [2], [17]
- Relate environmental and medical factors to incidence of disease. [1], [2], [17]
- List some characteristics of viruses. [1], [2], [16], [17]
- Discover the locations of significant community health agencies. [1], [2]

# SAMPLE CALENDAR

**This calendar is an example of how the Ninth Grade General Science course of study may be approached. Depending upon the nature of the students, this guideline will not be strictly applicable to every school.**

1985
FEBRUARY

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| February | | | | | 1<br>Greetings<br>Introduction<br>Overview |
| | 4<br>Pretest<br>Safety Lesson | 5<br>Lesson 1 | 6<br>Lesson 2 | 7<br>Lesson 3 | 8<br>Laboratory Lesson 3.1 |
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# MATERIALS TO BE USED IN THEME III

## UNIT 1

- aluminum foil
- articles and pictures of Love Canal
- BB shot
- beaker
- beakers
- burner or hot plate
- cardboard sheets (25 x 50 cm if possible)
- drinking containers (tall, clear plastic or glass)
- garbage (meat, bread, vegetables, newspapers, scrap metal, pieces of plastic)
- graduated cylinders
- granite
- hand lens or microscope
- hydrochloric or acetic acid (dilute)
- $H_2O_2$ solution 6%
- igneous rock samples (granite, basalt)
- index cards (5 in. x 8 in.)
- limestone
- marbles
- metamorphic rock samples (marble, slate, quartzite)
- metric ruler
- petri dishes
- pictures of gullies, dust-bowls, blow-outs, etc.
- plastic wrap
- rubber bands
- ruler
- run-off trays
- samples of granite, quartz, feldspar, mica, and clay
- scoop
- sedimentary rock samples (sandstone, shale, limestone)
- soil
- soil auger or spoon
- soil profiles in glass jars
- soil samples (clay, loam, sand, silt)
- soil samples rich in humus
- stirring rods
- tall jar with a tight-fitting cover
- transparent tape
- vegetable dyes (i.e., red, green, yellow, pink)
- watering cans (can be made by punching holes in the bottom of cans)
- wax marking pencil
- white glue

# UNIT 2

- alcohol burner
- aluminum foil
- ammonia
- beakers
- borax
- Bunsen burner
- Celsius thermometer
- cheesecloth
- clay
- clear plastic wrap
- coarse gravel
- coarse sand
- demineralized (distilled) water
- dirty water
- dye solution or cola drink
- Epsom salts
- filter paper
- fine gravel
- fine sand
- food dye
- funnel
- gauze
- glass chimney
- glass plate
- glass stirring rod
- glass tube
- graduated cylinder
- handouts depicting the water cycle
- hard water
- Hoffman apparatus
- hot pad
- humus
- ice cubes
- ink
- labels
- lift pump
- liquid detergent
- matches
- medicine droppers
- metric ruler
- New York State map
- one-hole rubber stopper
- overhead projector
- pH papers
- paper towels
- plant in a plastic bag
- right angle delivery tube about 25 cm long
- ring stand and ring
- rubber bands
- screen
- shiny metal can
- silver nitrate
- sodium chloride solution (10%)
- tap water
- test tube clamp
- test tube rack
- test tube with fitted one-hole stopper
- test tubes
- test tube stoppers
- thermometer
- tin pie plate
- tongs
- transparency depicting the water cycle
- transparency of a sewage
- treatment plant
- transparent tape
- triple beam balance
- tripod
- water samples with various pH
- wire
- wire gauze
- wooden splints

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## UNIT 3

air pump
alligator clips
aluminum foil
ammonium hydroxide
aneroid barometer
articles about recent environmental crises
articles and pamphlets on environmental laws
barometer
bell wire (25 cm in length)
bent glass tubing
blue litmus paper
bottle (containing air)
bottle of $CO_2$ (prepare before time from marble chips + HCl)
bottle of oxygen (prepare before time by using $MnO_2 + H_2O_2$)
chalk dust
coffee can
construction paper (28 cm x 21.5 cm)
cotton
cup
electrostatic generator
empty 2-liter plastic soda bottles
equal arm balance
flashlight or projector
football or basketball bladders
gas collecting jars
glass chimney about 60 cm tall
glass chimneys
hand lenses
hydrochloric acid (concentrated)
ice
incense stick
index card
jar with wide opening
large beakers (1000 cc, 2500 cc)
large rubber bands
list of occupations in the environmental field
Magdeburg hemispheres
matches
opaque projector
overhead projector
plastic drinking straws
plastic wrap
ring stand and clamp
rubber band
rubber sheet or balloon
sections of rubber hose
slides of air samples
smoke paper or incense stick
solid air pollutant slides
sodium bisulfite
straight glass tubing
Tesla coil
thistle tube
transparency showing atmosphere layers
transparent tape
two-hole rubber stoppers
watch glass
water
wire
wood splints

# MATERIALS TO BE USED IN THEME IV

## UNIT 1

- colored pens or pencils
- graph transparency
- marking pen
- overhead projector

## UNIT 2

- model and/or chart of a human heart, or transparency of heart
- overhead projector
- sphygmomanometer
- stethoscope

## UNIT 3

- adhesive tape
- balloon
- chart of blood cells
- chart of digestive system
- chart of ear
- chart of eye
- chart of microscope
- chart of respiratory system
- chart of skin
- chart of types of bacteria
- chart showing fungi, protozoa, worms
- cover slips
- dictionary
- fluorescein, or any fluorescent stain
- glass rod
- grease marking pencils
- hydrogen peroxide
- incubator
- lens paper
- letter "e" slides
- Lysol
- medicine dropper
- methylene blue solution
- microscopes
- mouthwash
- oil immersion lenses
- penicillin discs
- petri dishes with active colonies
- pictures of viruses
- slides
- slides of blood cells, plant cells, animal cells, etc.
- slides of different forms of bacteria
- slides of white blood cells
- sterile cotton swabs
- sterile petri dishes
- telephone book
- test tubes
- tincture of iodine
- ultraviolet light
- yogurt

# HAZARDS AND PRECAUTIONS

## Alcohol lamp

Use on a nonflammable surface, well away from the edge of the table. Make sure that the cap is not so tight that pupils cannot readily remove it. Check to see that any spilled alcohol is wiped up before the lamp is ignited. Make certain that the lamp does not tilt or leak. In no case are alcohol lamps to be filled by students. It is best that the lamps be filled the day before use, so that fumes are not present in the room. If filled the same day, wipe off all liquid from the outside of the lamp.

IN NO CASE SHOULD THE SUPPLY OF ALCOHOL BE PRESENT IN THE ROOM AT THE SAME TIME THE LAMPS ARE BEING USED.

## Eyes

Protect the eyes with goggles or face shields when heating substances, especially when there is danger of splattering. Do not rub the eyes after handling materials. Instruct pupils to direct the mouth of a test tube being heated away from themselves and others. Caution pupils never to look directly into the sun, but to project the image on a wall or screen. Use special goggles when working with ultraviolet light or when viewing a carbon-arc source.

## Asbestos

Wire gauze with asbestos centers, as well as asbestos pads, should be discarded according to the instructions on page 2 of Science Safety, K - 12. Suitable replacements for asbestos-containing materials may be found in catalogs of scientific supply houses, as well as in the New York City Board of Education Bureau of Supplies Catalog.

## Science Safety Manual

Additional safety procedures and precautions may be found in the New York City Board of Education publication, Science Safety: K - 12. A copy of this manual should be available in the office of the assistant principal in charge of science. Additional copies may be purchased from the Bureau of Supplies or the Publication Sales Store, Room 136, 110 Livingston St., Brooklyn, NY 11201. This safety manual should be read thoroughly by all instructors before teaching Ninth Grade General Science.

# THEME III

# THE ENVIRONMENT

# UNIT 1. SOIL

The following topics are covered in the Earth Science unit, (pp. 230-303) of the New York City science curriculum, grade 7.

- What valuable substances can be found with the earth's crust? (minerals)
- What are the properties of minerals?
- How are igneous rocks formed?
- How can we identify igneous rocks?
- How are sedimentary rocks formed?
- How do we identify sedimentary rocks?
- How do metamorphic rocks form?
- How do we identify metamorphic rocks?
- What causes the earth's surface to change?
- How does water wear away the surface of the earth?

Use the pretest that follows to determine what your students have already mastered.

## Pretest

NAME____________________________________CLASS______________DATE_______________

1. Rocks formed from molten materials that solidified on cooling are:
   a. igneous
   b. sedimentary
   c. metamorphic
   d. conglomerate

2. Which is a sedimentary rock:
   a. marble
   b. granite
   c. sandstone
   d. pumice

3. A rock which forms from accumulation and cementing of pebbles is:
   a. conglomerate
   b. slate
   c. shale
   d. gneiss

4. The rocks that form the crust of the Earth are made up of:
   a. minerals
   b. plants and animals
   c. ores
   d. sea animals

5. Crystal size in igneous rock depends upon:
   a. the chemicals found in the minerals
   b. the minerals that are present in the rock
   c. the rate at which the magma cools
   d. the size of the igneous rock

6. Rock formed from heat and pressure within the Earth is:
   a. metamorphic
   b. igneous
   c. sedimentary
   d. homogeneous

7. Three substances most responsible for weathering are:
   a. calcite, oxygen, and water
   b. carbon dioxide, kaolin, and oxygen
   c. clay, oxygen, and carbon dioxide
   d. oxygen, acids, and carbon dioxide

8. An agent of erosion that causes the greatest change in the Earth's surface is:
   a. moving ice
   b. running water
   c. wind
   d. temperature changes

NAME________________________________________

9. The cracking of rock by freezing water is an example of:
   - a. erosion
   - b. weathering
   - c. sedimentation
   - d. contraction

10. When hot magma cools slowly, the rocks that form:
    - a. have large mineral crystals
    - b. contain no mineral crystals
    - c. have the consistency of glass
    - d. have small mineral crystals

11. Chalk is:
    - a. an igneous rock
    - b. a metamorphic rock
    - c. a man-made synthetic
    - d. a sedimentary rock

12. Of the following, the one which is not a metamorphic rock is:
    - a. marble
    - b. schist
    - c. gneiss
    - d. shale

13. Dark igneous rock that contains iron and magnesium probably contains a large amount of the mineral:
    - a. calcite
    - b. flourite
    - c. olivine
    - d. quartz

14. When spaces between soil or rock particles fill with groundwater, the soil or rock is said to be:
    - a. eroded
    - b. weathered
    - c. saturated
    - d. evaporated

15. Particles formed from the weathering of quartz are:
    - a. silt
    - b. sand
    - c. clay
    - d. humus

## Lesson 1: THE SOIL

AIM: "Why is soil important to us?"

PERFORMANCE OBJECTIVES: The students will be able to:

. identify samples of sedimentary, igneous, and metamorphic rocks.
. state three reasons why soil is important to city residents.

MATERIALS: Beaker of soil, igneous rock samples (granite, basalt), sedimentary rock samples (sandstone, shale, limestone), metamorphic rock samples (marble, slate, quartzite).

MOTIVATION: Show class a handful of soil. Tell students that this was once part of a rock mountain. Ask: "What happened to the mountain?" List students' responses on the chalkboard.

DEVELOPMENT

1. Elicit the importance of soil (food, clothing, and lumber).

2. Show and distribute samples of igneous rocks. Ask: "How do you think these rocks originated?" (from fire or heat) (Review from 7th grade.)

3. Distribute samples of sedimentary rocks. Ask the students to speculate on their origin. Compare igneous and sedimentary rocks.

4. Distribute samples of metamorphic rocks. Have students compare to igneous and sedimentary rocks. "How did metamorphic rocks form?"

   Igneous and sedimentary rocks that are buried deep inside the earth may change in appearance or in mineral content. Many conditions cause metamorphic rocks to form from older rocks. Heat may change the original minerals of rocks into other minerals. Pressure from the weight of the rocks above can rearrange the atoms in the minerals of a rock.

   Heat and pressure will usually change the appearance of a rock. The minerals in metamorphic rocks may line up in colored bands that bend and fold as a result of great pressure.

SUMMARY

1. "Which do you think came first, igneous or sedimentary rock?" "Explain your reasoning."

2. "Why is the soil on a farm in northern New York State important to a person living in a borough of New York City?"

## Lesson 2: ROCKS AND SOIL

AIM: "How do rocks become soil?"

PERFORMANCE OBJECTIVES: The students will be able to:

- explain four ways in which weathering occurs.
- recognize evidence of weathering on neighborhood stone objects--buildings, gravestones, etc.
- present evidence that weathering takes a very long time.

MATERIALS: Two pieces of granite, beaker of soil, limestone, burner or hot plate, beaker of cold water, dilute hydrochloric or acetic acid, jar of frozen water (jar must be completely filled with water first and tightly capped), round and angular pebbles.

MOTIVATION: Rub two pieces of granite together. Ask: "How long before we will get a cupful of soil?"

DEVELOPMENT

1. Demonstrate the effect of rapid changes of temperature by dropping a heated piece of limestone into a beaker of ice water. Relate to natural conditions.

2. Display a small jar of water which was tightly capped, then frozen. Ask the students to explain how something like this could happen on a mountain.

3. Show the class a picture of a factory emitting smoke. Point out that oxides of sulfur in the smoke form acids. Also that a $CO_2 + H_2O \rightarrow H_2CO_3$ reaction takes place in the atmosphere. Demonstrate the effect of acetic acid or dilute hydrochloric acid upon limestone.

4. Discuss, using an appropriate visual aid, the effect of a glacier upon rock. Also describe any evidences of glaciers that can be observed near the school. (At the end of the glacier where the ice melts, a ridge of glacial materials are deposited. This is called a terminal or end moraine.) Northern Long Island is a good example of a terminal moraine. There are many boulders. These decrease in size as we go south on Long Island, finally becoming sand grains at the beach and nearby sea. Outwash plain: A water-sorted deposit that forms a large flat area as the glacier melts.

5. Discuss wind and water erosion. Display smooth, round pebbles and small angular rocks. Have students explain how the pebbles became round.

6. Distinguish between "weathering" which is the breaking up of rock into smaller particles and "erosion" which involves both breaking up and transporting rocks.

## SUMMARY

1. "State three ways that water can wear away a rock."
2. "How could you tell if a rock has undergone weathering?"
3. "How has man speeded up the weathering of rocks?"

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Why is granite used in buildings.
2. How does the depth of New York harbor demonstrate the erosive power of ice? How does this help us explain the erosive power of a glacier?

ESSENTIAL VOCABULARY

1. granite
2. igneous
3. sedimentary
4. soil
5. glacier
6. carbonic acid
7. erosion
8. weathering
9. metamorphic
10. terminal moraine
11. outwash plain
12. mineral

# Lesson 3: SOIL COMPOSITION

AIM: "What substances are found in soil?"

PERFORMANCE OBJECTIVES: The students will be able to:

- relate the dependence of soil and living things upon each other.
- state the composition of humus.
- distinguish humus from the inorganic material in soil.

MATERIALS: Laboratory Worksheet 3.1, soil samples rich in humus, petri dish, hand lenses. (Optional: microscopes and slides).

MOTIVATION: "What can we discover in a soil sample by looking at it with a hand lens or microscope?"

DEVELOPMENT

1. Ask: "What is humus?"

   Humus is decayed plant and animal matter that is found in topsoil. Humus gives topsoil its dark color and helps the soil hold moisture. Humus contains acids that leach minerals from the topsoil.

2. Refer to Laboratory Worksheet 3.1.
3. Distribute soil samples, petri dish sections, and optical hardware.
4. Guide the students through Laboratory Worksheet 3.1.

SUMMARY

1. "What is the color of humus?"
2. "How can you distinguish humus from rock particles in the soil?"
3. "Why is humus the most important part of the soil you examined today?"
4. "How do you think bacteria and molds have helped to form humus?"

# LABORATORY WORKSHEET 3.1

NAME________________________________ CLASS______________ DATE______________

**PROBLEM:** What can we discover by examining soil with a magnifier?

**MATERIALS:** Hand lens or microscope, 10 ml of soil in a half of a petri dish.

**INTRODUCTION:** As we have already learned, soil is the result of the weathering of rocks. But as you will discover today, soil contains much more than lifeless rock particles.

**PROCEDURE:**

1. Spread out your soil sample into a thin layer in a petri dish.
2. Examine your sample with either the hand lens or microscope provided. Search for anything that looks like wood. In the space below, describe your magnified soil sample in words and make a sketch in the circle.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

## LABORATORY WORKSHEET 3.1 (continued)

3. Examine your soil sample for parts of trees or plants. Can you find any roots? Any stems? Any leaf parts? If so, draw what you find and label your drawings.

4. Locate grains of sand or rock particles. Draw them.

5. Are there any insects in your soil sample? If so, what did you discover?

____________________________________________________________

____________________________________________________________

### SUMMARY/HOMEWORK

1. Why is the decay of the remains of plants and animals useful in the building of soil?

2. Why may soil in one place be quite different from soil only one kilometer away?

## Lesson 4: SOIL PROFILES
[OPTIONAL]

AIM: "What can we learn from a soil profile?"

PERFORMANCE OBJECTIVES: The students will be able to:

- create a soil profile.
- compare soil profiles and identify immature soil from the profile.
- identify mature soil from its profile.

MATERIALS: Soil profiles in glass jars, cardboard sheets (25 x 50 cm if possible), white glue, soil auger or spoon.

MOTIVATION: Have students view a triple-decker sandwich or a layer cake from the top. Ask: "How can you tell what's inside?" "What would you have to do in order to find out?" (Relate this to looking at soil and seeing only the top layer.)

### DEVELOPMENT

1. Ask: "What is a soil profile?"

   A soil profile is a side view of a deep sample of soil, showing the various layers of material that make up the soil in a particular area. The profile of a typical soil sample is the product of the action of vegetation, temperature, rainfall and soil organisms on parent rock materials, operating for many thousands of years. The soil profile is of great economic importance for it can tell which soil is best suited for agricultural crops, for timber, wildlife, etc. The soil profile also reveals the suitability of the soil for specific uses such as sites for homes, highways, and landfills.

2. Guide the students through Laboratory Worksheet 3.2.

3. Show the class an actual soil profile and discuss its stage of development.

4. Make a soil profile model:

   a. Fold a cardboard sheet in half, the long way.
   b. Cover the longitudinal fold with glue.
   c. Using the soil auger or spoon, take a soil sample every 5 cm from a tall glass jar filled with layers of soils.
   d. Place the soil samples on the fold of the cardboard in the order they come out of the jar. Press the soil gently onto the glue.
   e. Allow to dry.

### SUMMARY

1. "How does your soil profile compare to those on Laboratory Worksheet 3.2?"

2. Have the students prepare a soil profile from soil at the school grounds or a nearby vacant lot or park.

# LABORATORY WORKSHEET 3.2

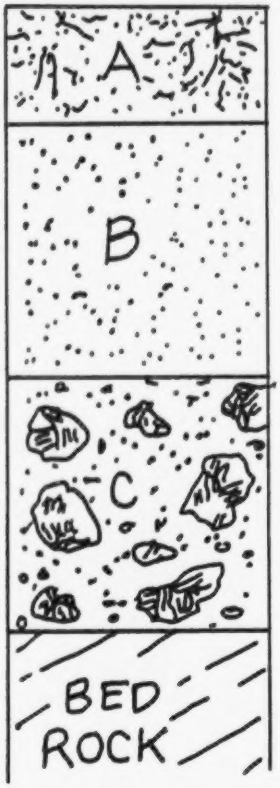
NAME________________________________ CLASS______________ DATE______________

PROBLEM: What can we learn from a soil profile?

INTRODUCTION: In order to see what is in the soil, we have to examine it from the side. Such a view is called a soil profile. The layers in a soil profile are called horizons. The uppermost horizon is named Horizon A; the next Horizon B, and so on. By examining a soil profile, a soil scientist can tell many things, such as if the soil is suitable for farmland, recreational areas, or homes.

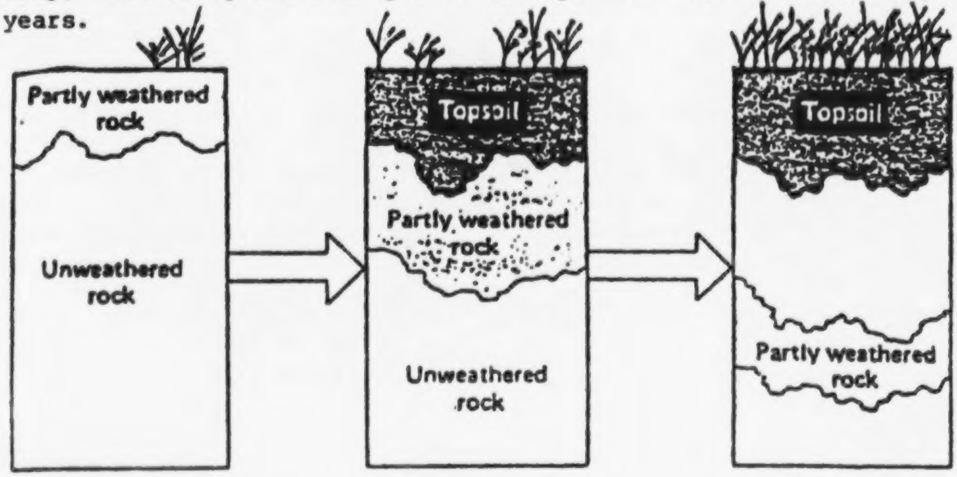
PROCEDURE

1. This is what a soil profile might look like:



## LABORATORY WORKSHEET 3.2 (continued)

2. In its original state, there is unweathered rock at the surface. Gradually, weathering and soil growth take place. This can take many, many years.


Partly weathered rock
Unweathered rock
Topsoil
Partly weathered rock
Unweathered rock
Topsoil
Partly weathered rock

Immature soil Immature soil Mature soil

3. Observe the soil profile your teacher has displayed.

   a. How many horizons can you see?

   b. Draw it below to the best of your ability. Label each horizon.

## LABORATORY WORKSHEET 3.2 (continued)

c. Was this soil profile taken from immature or from mature soil? How do you know?

________________________________________

________________________________________

d. Name three weathering processes that are responsible for Horizon B.

________________________________________

________________________________________

________________________________________.

e. How was Horizon A formed?

________________________________________

________________________________________

SUMMARY/HOMEWORK

1. Which soil profile would be best suitable for building a 25-story apartment house? Why?
2. If you were a soil scientist, which soil horizon would you suggest a farmer look for when purchasing a farm? Why?

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. The elements essential for plant life are obtained from the air and the soil. What are these elements? Would the lack of these elements affect animal life? Explain.

2. How does humus help plant growth? According to the soil profile, where is humus found?

ESSENTIAL VOCABULARY

1. decomposition
2. humus
3. molds
4. profile
5. horizon
6. immature
7. mature

## Lesson 5: WATER IN THE SOIL

AIM: "How does the size of soil particles affect the amount of water in the soil?"

PERFORMANCE OBJECTIVES: The students will be able to:

- explain why clay particles are the smallest particles in soil.
- define soil as a mixture of clay, sand, and silt in different proportions.
- explain why sandy soil holds less moisture than soil with clay in it.

MATERIALS: Laboratory Worksheet 3.3, 5 x 8 in. index card, BB shot, graduated cylinder, marbles, metric ruler, soil samples, tall jar with a tight fitting cover, transparent tape, two beakers of equal size: one two-thirds filled with marbles, the other two-thirds filled with BBs or small steel bearings.

MOTIVATION: "What precautions should you take to prevent your house plants from drying out when you go on vacation?"

### DEVELOPMENT

1. Guide students through Laboratory Worksheet 3.3.

   a. For Procedure 1, use several soil samples from different locations so that each team will not get the same results.

   b. Perform Procedure 2 of the worksheet as a demonstration.

   c. It may take more than one laboratory period to complete Laboratory Worksheet 3.3.

2. Have the students tabulate their results including depths in millimeters and percentage of total depth.

### SUMMARY

- See Laboratory Worksheet 3.3.

# LABORATORY WORKSHEET 3.3

NAME__________________________________ CLASS_______________ DATE_______________

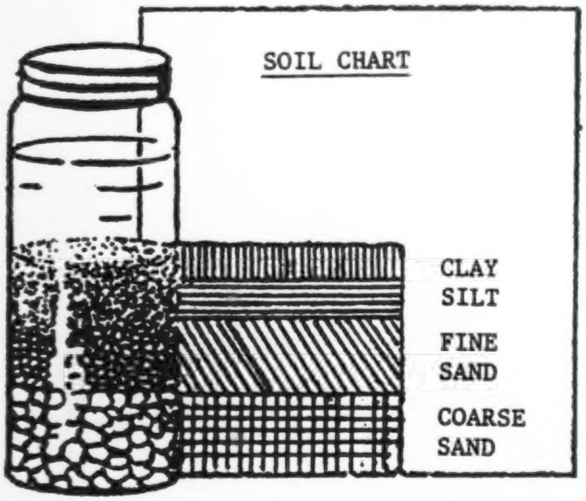
**PROBLEM:** How much water can different types of soil retain?

**MATERIALS:** 5 x 8 index card, BB shot, graduated cylinder, marbles, metric ruler, soil samples, tall jar with a tight-fitting cover, transparent tape, two beakers of equal size: one two-thirds filled with marbles, the other two-thirds filled with BBs or small steel bearings.

**INTRODUCTION:** Most soils found in nature contain a mixture of sand, silt, and clay particles, plus humus. The proportion of each will vary from soil sample to soil sample. You will learn today how particle size determines the ability of the soil to hold water.

## PROCEDURE

1. Fill a tall jar about two-thirds full of water.
2. Add enough soil to almost completely fill the jar.
3. Cover the jar tightly and shake it vigorously for about three minutes.
4. Place the jar on a horizontal surface and leave it undisturbed for several minutes until the particles settle and the water on top is clear.
5. Tape an blank index card to the back of the jar.



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## LABORATORY WORKSHEET 3.3 (continued)

6. Based on your observations thus far, prepare a diagram similar to the preceding one. The heaviest and largest particles will be on the bottom. Try to make your drawing as accurate as possible.

7. If it is possible, leave the jar undisturbed until the next science period. This will allow sufficient time for even the finest of particles to settle out.

8. Using your metric ruler, complete the following table:

   a. The total depth of soil in the jar is _____ mm.
   b. The thickness of the sand layer is _____ mm.
   c. The thickness of the silt layer is _____ mm.
   d. The thickness of the clay layer is _____ mm.
   e. In this soil sample, _____% is clay, _____% is silt and _____% is sand (by volume).

9. Fill a graduated cylinder with water and record the water level. ______ml

10. Pour water from the graduated cylinder into your beaker that is two-thirds full of dry marbles. Then pour the water back into the graduated cylinder and record the water level again. ______ml

11. Subtract the levels recorded in steps 9 and 10 to find the amount of water that was retained by the marbles. ______ml

12. Repeat the procedures of steps 9 to 11 using your other beaker that is two-thirds full of dry BBs. How much water was retained by the BBs? ______ml

13. a. Which held more water, BBs or marbles? _______________

    b. Explain why either the marbles or the BBs held more water.

    ____________________________________________________________

    ____________________________________________________________

SUMMARY/HOMEWORK

1. How does size of soil particle affect the amount of water that the soil can hold?

2. Why does sandy soil hold less moisture than clay soil?

## Lesson 6: SOIL ABSORBTION AND RETENTION OF MOISTURE
[Optional]

AIM: "How much moisture can different kinds of soil hold?"

PERFORMANCE OBJECTIVES: The students will be able to:

- identify humus content as a factor in the water-holding power of a soil sample.
- relate humus content and particle size to the water content of various soils.

MATERIALS: Beakers, various dry soil samples (clay, loam, sand, silt) from denuded playground or from a garden, metric ruler, 100 ml graduated cylinder.

MOTIVATION: Demonstrate by measurement that a block of wood 2 x 4 x 6 has less surface area than two blocks of wood, each 2 x 4 x 3. Ask: "How does this relate to a soil's ability to retain water?"

DEVELOPMENT

1. Encourage students to collect at least a 25 ml soil sample from their gardens or other areas. Make arrangements to dry the soil samples in an oven for one hour.
2. Divide the class into groups.
3. Distribute beakers (all of the same size), one to each group.
4. Fill the beakers with soil until there is about a 5 cm space left at the top of the beaker.
5. Using the graduated cylinder, have the students add only as much water to the soil as can be absorbed. Caution the students to stop adding water when drops of water appear on the bottom of the beaker. Each group should record the amount of water absorbed by their soil sample.
6. Tabulate the results on the board.

| Soil Sample | Amount of Water Absorbed (ml) |
|---|---|
| | |

7. Discuss the results and focus upon the soil type that held the most water. "How much humus did it have?" "What kind and proportion of particles were in it?"

8. Repeat Step 7 for the soil sample that absorbed the least water.

9. Try to elicit the generalization that humus content and particle size are the key factors for the absorption of water by soil.

## SUMMARY

1. "When the humus in soil is used up, the soil becomes compact rather than clumpy."

   a. "Which type of soil takes in water faster, compact or clumpy soil?"______________________

   b. "Which type can hold more water?" _________________________________

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Why is soil considered a water reservoir?
2. Do the "pores" or spaces between the soil particles hold any importance to plant growth? How?
3. How does soil act like a sponge?

ESSENTIAL VOCABULARY

1. silt
2. proportion
3. coarse
4. absorbed
5. capillary action
6. moisture
7. compact
8. clumpy

# Lesson 7: ORGANIC MATTER IN SOIL

[Optional]

AIM: "How can the amount of organic matter in a soil sample be estimated?"

PERFORMANCE OBJECTIVES: The students will be able to:

- compare the amount of organic matter in different soil samples.
- predict which soil sample would be best for agricultural purposes.
- use hydrogen peroxide to determine the relative amount of organic matter in soil.

MATERIALS: Laboratory Worksheet 3.4; for each group of students experimeters: four 250 ml beakers, two soil samples from the same site (one taken from the top 5-10 cm depth, the other from 40-50 cm depth), wax marking pencil, 6% $H_2O_2$ solution, scoop, ruler.

MOTIVATION: Show the class two soil samples from the same site. "Which has the most organic matter in it?"

## DEVELOPMENT

* **NOTES TO TEACHER:**

a. Do not dilute 30% $H_2O_2$. To avoid waste and accident, it would be best to use either 6% $H_2O_2$ or 3% $H_2O_2$. Both are available in drugstores or beauty parlor supply stores.

b. Soil may be dark because of the presence of sulfides, oxides and carbonates of various metals.

1. Divide the class into groups.
2. Distribute Laboratory Worksheet 3.4 and materials.
3. Guide the students through the worksheet.

## SUMMARY

- See Laboratory Worksheet 3.4.

## FOR FURTHER THOUGHT

- See Laboratory Worksheet 3.4.

# LABORATORY WORKSHEET 3.4

NAME________________________ CLASS______________ DATE______________

**PROBLEM:** How can the amount of organic matter in a soil sample be estimated?

**MATERIALS:** For each group of student experimeters: four 250 ml beakers, two soil samples from the same site (one taken from the top 5-10 cm depth, the other from 40-50 cm depth), wax marking pencil, $H_2O_2$ solution (6%), scoop, ruler.

**INTRODUCTION:** Today you will determine the amount of organic matter in a soil sample. This test is often performed by a soil technician for a soil scientist. Soil rich in organic matter is necessary if crops are to be grown. Usually, the organic matter in soil is dark in color due to its high carbon content. Hydrogen peroxide ($H_2O_2$) oxidizes carbon compounds. Often, when a compound is oxidized, its color changes. This is why $H_2O_2$ is used to bleach hair. We will see how $H_2O_2$ affects the color of our soil samples.

**CAUTION:** You must wear safety goggles at all times during this laboratory period.

**PROCEDURE**

1. Label your beakers 1, 2, 3, and 4.
2. In beakers 1 and 2, place 4 cm of soil taken from the upper layers.
3. Place 4 cm of soil taken from the deeper layers into beakers 3 and 4.
4. Add water to beakers 1 and 3 to just cover the soil samples.
5. Add 6% $H_2O_2$ to cover the soil in beakers 2 and 4.
6. Observe all beakers carefully. In which beaker do you observe the most bubbling?

   ____________________

   In which do you observe the least? ______________

7. Wait until all bubbling has stopped. If the liquid in beakers 1 and 2 is not clear, add some water and wait until clearing takes place.

## LABORATORY WORKSHEET 3.4 (continued)

SUMMARY/HOMEWORK

1. Compare the colors of the soil samples.

   A. How does the color of the soil in beaker 1 compare with the color in beaker 2?

   B. Compare the soil color in beakers 3 and 4.

   C. How does the soil color of beaker 2 compare to that in beaker 4?

   D. Explain your observations.

2. Why are beakers 1 and 3 important for this experiment?

3. Why do your soil samples have different amounts of organic matter?

4. Why might a soil scientist want to have this test performed?

## Lesson 8: SOIL TRANSPORT

AIM: "How is soil moved?"

PERFORMANCE OBJECTIVES: The students will be able to:

- describe three ways by which parent material for soils is moved.
- state the interrelationships between plants and soil.

MATERIALS: Laboratory Worksheet 3.5, soil samples, samples of granite, quartz, feldspar, mica, and clay; pictures of gullies, dust-bowls, blow-outs, etc.

MOTIVATION: "Why do we find different kinds of soil in different parts of the country?"

DEVELOPMENT

- Guide the students through Laboratory Worksheet 3.5.

* **NOTE TO TEACHER:**

Parent material refers to rocks which have been broken down. Any type rock can become soil parent material after it has been broken down into small pieces as a result of weathering. After parent material is present, soil can form through the addition of dead organic matter, microorganisms, plants and animals.

The U.S. Department of Agriculture has mapped more than 70,000 soil types over an area of 500 million acres. Soil types are designated by locality and texture. Soil types are assembled into ten major classification units called orders. Some representative soil orders are as follows:

Desert soil is found in areas of the western states. Water readily evaporates from the soil sometimes leaving a layer of calcium carbonate behind. There are not enough rotted plants to form good topsoil.

Prairie soil forms in the grasslands of the Great Plains and the Middle West, where the climate is not so dry. A good, thick topsoil develops which is excellent for farming.

Forest soil is found in the eastern part of North America. Here great amounts of precipitation help plant growth.

Mountain soil found in western United States is usually rocky. There are many kinds depending upon local conditions.

Tundra soil is found in northern Canada and the Arctic. The topsoil does not develop well here because of the short growing season and the few plants.

# LABORATORY WORKSHEET 3.5

NAME________________________________ CLASS______________ DATE_______________

PROBLEM: How is soil moved?

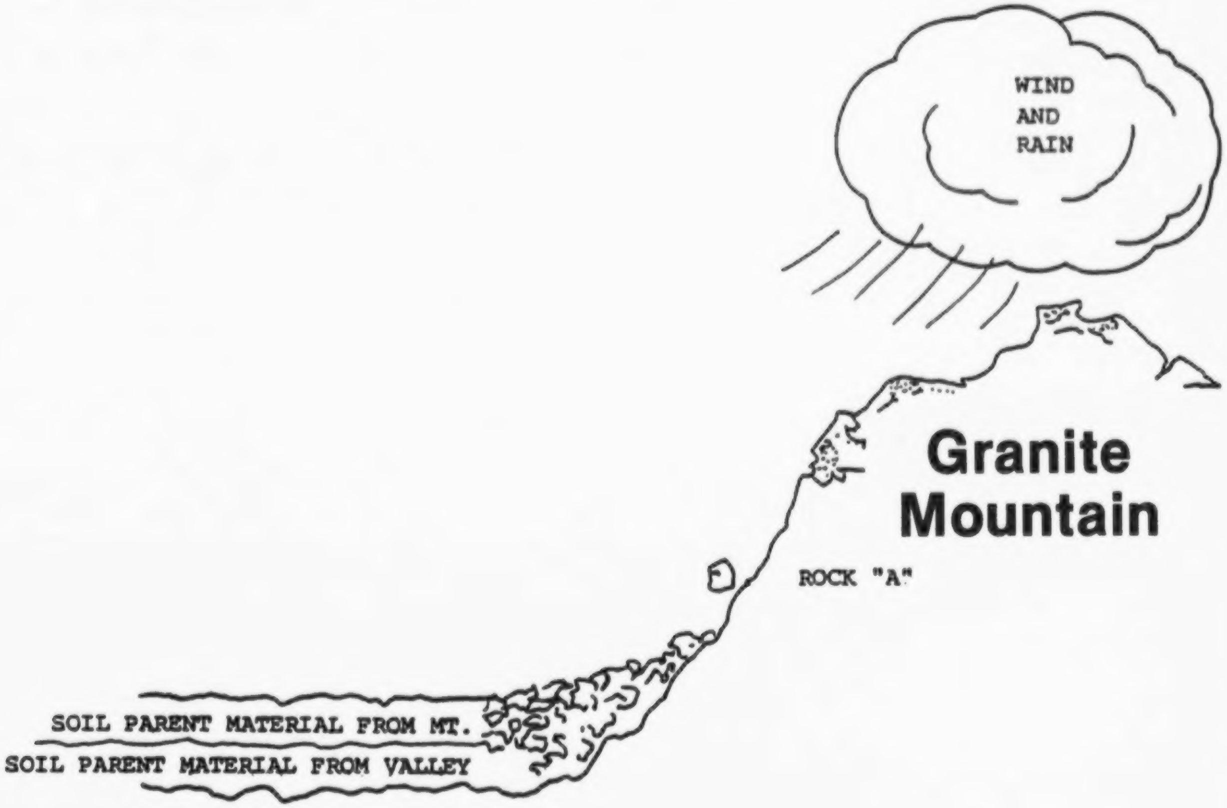
MATERIALS: Soil samples; samples of granite, quartz, feldspar, mica, and clay; pictures of gullies, dust-bowls, blow-outs, etc.

INTRODUCTION: Many things influence soil movement, especially water and wind. Before we can discuss the factors that make the soil in New York State different from that in Alaska, we must talk about parent material. The parent material consists of broken rocks.

PROCEDURE

I.

1. Examine the illustration below. Study it and then answer the questions that follow.


WIND
AND
RAIN
Granite
Mountain
ROCK "A"
SOIL PARENT MATERIAL FROM MT.
SOIL PARENT MATERIAL FROM VALLEY

# LABORATORY WORKSHEET 3.5 (continued)

2. Three ways that small rocks and rocky material can get from the top of the mountain to the valley below are:

   A. ______________________________

   B. ______________________________

   C. ______________________________

3. What force is moving rock A down the mountain?

   ______________________________

4. Why is the term "soil parent material" an appropriate term?

   ______________________________

5. What must be added to soil parent material to change it into "soil"?

   ______________________________

6. Compare the composition of the soil at point 1 with the composition of soil at point 2.

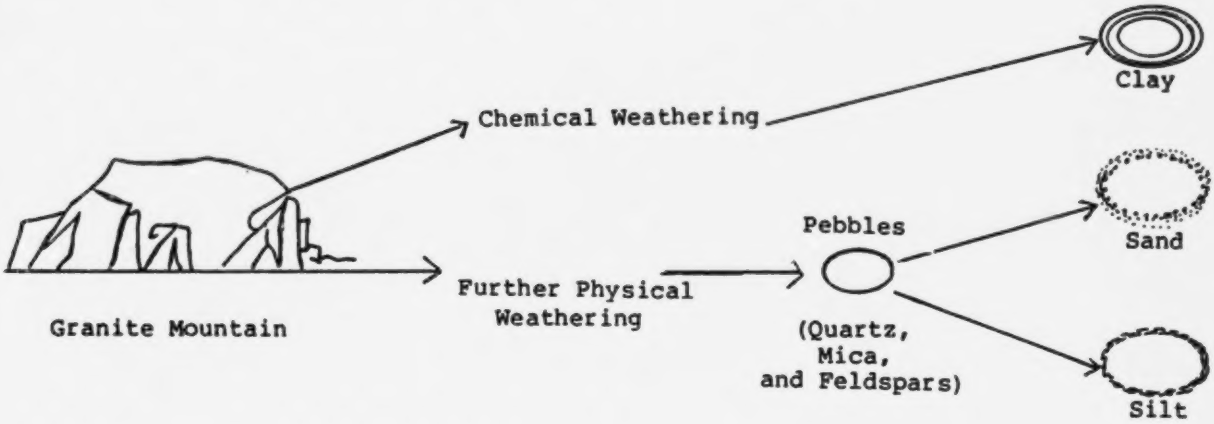
   ______________________________

7. What could be done to keep the soil at point 1 from being moved to point 2?

   ______________________________

II.

1. Examine the following diagram that illustrates how granite is weathered. Your teacher will distribute samples of granite, quartz, feldspar, mica, and finally clay. Examine them carefully, and referring to the chart, answer the questions that follow.


Chemical Weathering
Clay
Pebbles
Sand
Granite Mountain
Further Physical Weathering
(Quartz, Mica, and Feldspars)
Silt

2. What chemicals can cause weathering?

________________________________________

3. Describe the appearance of the mica you saw in the granite rock.

________________________________________

4. What are two ways that mica differs from quartz?

________________________________________

________________________________________

SUMMARY/HOMEWORK

1. Why will the soil parent material in a valley be different from the soil parent material in the surrounding mountains?
2. Why is the planting of grass a good way to prevent the loss of topsoil?
3. Cite evidences that prove that soil is being made by natural forces at this very moment.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

### ESSENTIAL VOCABULARY

1. organic
2. estimated
3. agriculture
4. site
5. weathering
6. bleach
7. sufficient
8. gully
9. oxidation

# Lesson 9: TOPSOIL DENUDATION

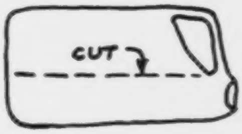
AIM: "How can our topsoil be lost?"

PERFORMANCE OBJECTIVES: The students will be able to:

. demonstrate that plants help prevent soil erosion.
. identify plants as providing organic matter to the soil.
. predict areas that are prone to erosion from rain water.

MATERIALS: Laboratory Worksheet 3.6; two one-liter graduated cylinders; two run-off trays, one with sod, the other with bare soil; two watering cans (can be made by punching holes in the bottom of cans).

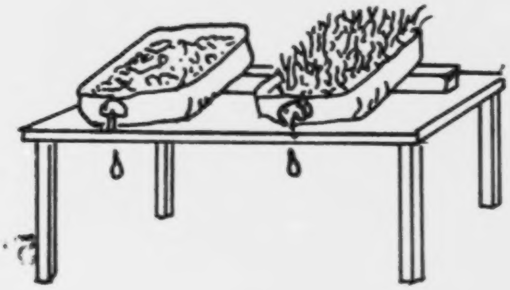
* **NOTE TO TEACHER:** Trays can be made from plastic milk containers of one-gallon size. See diagram below:



MOTIVATION: "Each year our farms lose topsoil that is very precious and took hundreds of years to form. How does this happen?"

DEVELOPMENT

1. Prepare two trays as indicated below. The graduated cylinders are added later.



2. Obtain or prepare two watering cans (see materials).

3. Fill one tray with sod, the other with bare soil.

4. Tilt both trays to the same angle by raising the rear. Be sure the tray openings are to the front.

5. Guide students through Laboratory Worksheet 3.6.

6. Discuss the numerous effects of soil erosion. They include loss of soil and soil fertility, ruined and unproductive fields, and loss of water as runoff. This can lead to crop failures: decreased land values; silt build-up in lakes, streams, and reservoirs; abandoned farms; and destruction of wildlife.

SUMMARY

- See Laboratory Worksheet 3.6.

FOR FURTHER THOUGHT

- "What are the areas of bad soil erosion in North America?" "Give the reasons for erosion in these areas."

# LABORATORY WORKSHEET 3.6

NAME ______________________ CLASS ____________ DATE ____________

**PROBLEM:** How can our topsoil be lost?

**MATERIALS:** Two run-off trays, one with sod, the other with bare soil, two one-liter graduated cylinders, two watering cans.

**INTRODUCTION:** Each year more and more soil in the central United States becomes unfit for farming. This is because a good deal of the all-important topsoil has disappeared leaving a hard surface made of packed soil and small pebbles. The loss was due to erosion and caused by wind, water, and ice.

During the early days of this country, the leaves of trees in the forests and the grasses of the prairies softened the force of the rain drops. This meant that the rain could fall for many hours without damaging the soil. The humus in the topsoil that was formed by decaying plant parts soaked up most of the water from even the heaviest rains. Today, however, the trees and grasses have been removed to make way for farmland. Now, the bare ground, with few plants, takes the full force of the rain.

## PROCEDURE

. Explain your procedure step by step in the space below.

### Part I

Using the equipment provided, design an experiment to determine which tray of topsoil would be more easily washed away by rain water.

From the results you obtained in your experiment complete the following:

A. Amount of water collected from bare soil tray = ________ml

B. Amount of water collected from the sod tray =__________ml

C. Which graduated cylinder had muddier water? ______________________

D. What conclusions can you draw from the data? ______________________

________________________________________________________________

Part II

Read the following passage. Do your data and conclusions agree with this reading passage?

> When rain falls on bare earth, very little soaks into the soil. Instead, it runs off carrying large amounts of topsoil with it. As more and more soil is eroded by the rains, less soil remains. Also, the remaining soil loses its ability to absorb water. The effects of erosion by water get worse and worse with each rainstorm. When soil in this condition dries out, it is very easily blown away.
>
> Water and wind erosion result in the loss of soil and the loss of the ability to grow crops, as well as the loss of water. During periods of heavy rain, rivers soon become flooded because the water is flowing over the soil rather than being absorbed by it. Floods can now occur quickly and easily. When little or no rain is absorbed by an eroded area, a drought soon occurs.

SUMMARY/HOMEWORK

1. In what ways have people had a negative effect upon our topsoil?

2. How do plant roots help hold soil in place?

3. How else do plants protect the soil?

4. "Soil erosion, if untreated, gets worse and worse each year." Explain this statement.

5. Prepare a report on methods used to prevent soil erosion due to the action of water and wind.

# Lesson 10: DISPOSAL BY LANDFILL

AIM: "What goes on inside a landfill?"

PERFORMANCE OBJECTIVES: The students will be able to:

- predict how long it will take for various forms of garbage to decay in a landfill.
- recognize and describe the problems caused by disposal of garbage in landfills.
- assess the value of creating new landfills.

MATERIALS: Laboratory Worksheet 3.7, one dozen or more tall clear plastic or glass drinking containers, soil, aluminum foil, plastic wrap, rubber bands, stirring rods, garbage (meat, bread, vegetable, newspapers, scrap metal, pieces of plastic), four different vegetable dyes (i.e., red, green, yellow, pink).

MOTIVATION: "What is a landfill?"

DEVELOPMENT

1. Explain that the most extensively employed disposal method today is the sanitary landfill, in which wastes have been deposited in a trough that has been excavated in a low-value area of town. Sometimes a "borrow pit" or abandoned gravel pit is selected as a site. At the end of each day's dumping, the accumulated trash is compacted and then covered with a layer of soil. This method minimizes air and water pollution, restricts fly and rodent breeding, and reduces the possibilities for the dispersal of disease organisms. There are also fringe benefits that might accrue once the landfill site's use for solid waste disposal has ended such as

    a. recreational facilities

    b. landscaping value

    c. soil-bank rehabilitation to erase scars of strip mining

    d. educational parks - former landfills have been connected to educational parks where children can study wildlife and ecology.

2. Distribute Laboratory Worksheet 3.7; divide the class into groups.

3. Guide the students through Laboratory Worksheet 3.7.

4. Ask: "What are some disadvantages of landfills?"

    A drawback to landfills is that they require large acreages of land. For example, a community with a population of 10,000 people generates so much trash that a single year's production would cover a whole acre to a depth of 6 feet. As the garbage and other organic refuse is decomposed by bacterial activity, a potentially explosive gas, methane, is produced. Ordinarily, the amount of methane produced is no cause for concern. However, if large concentrations of the gas accumulate, the possibility exists for an explosion which could be highly destructive to homes built on the landfill site.

## SUMMARY

- See Laboratory Worksheet 3.7.

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# LABORATORY WORKSHEET 3.7

NAME______________________________ CLASS______________ DATE______________

**PROBLEM:** What goes on inside a "mini-landfill"?

**MATERIALS:** One dozen or more tall clear plastic or glass drinking containers, soil, aluminum foil, plastic wrap, rubber bands, stirring rods, garbage (meat, bread, vegetables, newspapers, scrap metal, pieces of plastic), four different vegetable dyes (i.e., red, green, yellow, pink).

**INTRODUCTION:** Many communities get rid of their garbage by burying it under a covering of soil. This is called a landfill. If a city disposes of garbage by this method, an acre of ground (4047 square meters) about 2 meters deep is necessary for every 10,000 people each year.

Today you are going to set up two simple experiments related to landfills. The first will allow you to see what happens under the surface of a landfill. The second experiment will show you what happens to biodegradable materials in the soil.

**PROCEDURE**

1. Fill a tall glass or plastic drinking container with soil to within 3 cm of the top.

2. In each, bury pieces of garbage (meat, vegetable matter, bread, newspaper, plastic, metal) at varying depths. (If more than one group of students is doing this experiment, each group should bury its garbage at different depths.) Place each piece of garbage next to the outer edge of the drinking container. In this way, you can make visual observations of each sample of garbage.

3. Moisten the soil, but don't get the soil waterlogged.

4. Cover each container with a piece of aluminum foil held snugly in place with a rubber band.

5. Wait three days, then examine your garbage landfill daily and keep a record, on the chart provided, of how rapidly each garbage item decomposes. Express the amount decomposed as a fraction or as a percentage of the original sample.

## LABORATORY WORKSHEET 3.7 (continued)

Percent Decomposed

| garbage item | 3 days | 5 days | 7 days | 9 days |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

SUMMARY/HOMEWORK

1. Did you see any spaces where garbage had been? ________________
   If so, how can you account for the empty space?
   ______________________________________________________________
2. What is in these spaces? ________________________________________
3. In Los Angeles, a landfill that was 90-feet deep sank over 5 feet in three years. What can this landfill be used for?
   ______________________________________________________________
4. You need 4047 square meters of ground 210 cm deep for every 10,000 people each year if you dispose of garbage by the use of landfills. The population of your community is ____________ people. How much land will you need for your community in the next five years? (Assume that your landfill can be 42 meters tall.)

# ADDITIONAL IN-CLASSROOM ACTIVITIES

## ESSENTIAL VOCABULARY

1. precious
2. sod
3. landfill
4. assess
5. sanitary
6. aeration
7. bacteria
8. biodegradable
9. waterlogged
10. enzyme

## Lesson 11: DANGERS CAUSED BY LANDFILLS

AIM: "Why is it dangerous to bury toxic wastes in landfills?"

PERFORMANCE OBJECTIVES: The students will be able to:

. explain why the residents of Love Canal had to be relocated.
. identify several health problems associated with the toxic wastes at Love Canal.
. associate Love Canal with the "mini landfill" experiment.

MATERIALS: Student Worksheet 3.8, articles and pictures of Love Canal from the vertical file of a library.

MOTIVATION: "In 1980, President Carter declared a state of emergency in the Love Canal section of Niagara Falls. Because they were afraid for their lives, the 710 families that lived there were relocated. Since then, no one has lived in the Love Canal area. How did a landfill cause these problems?"

DEVELOPMENT

1. Distribute Laboratory Worksheet 3.8.
2. Have the students read silently or aloud.
3. Guide the class through the worksheet.

SUMMARY

. See Worksheet 3.8.

FOR FURTHER THOUGHT

. Have students research other areas that have developed similar problems relating to toxic waste disposal.

* **NOTE TO TEACHER:** Other articles on environmental problems are included. Reading worksheets can be designed based on these articles. It would also be appropriate to include current material.

# LABORATORY WORKSHEET 3.8

NAME______________________________ CLASS______________ DATE______________

PROBLEM: What problems were caused by the landfill at Love Canal?

INTRODUCTION: On May 21, 1980, President Carter declared a state of emergency at the Love Canal in Niagara Falls, N.Y. He authorized the government to pay for the relocation of 710 families. Let's find out how a landfill caused this emergency.

PROCEDURE

1. Read the following excerpts from Time Magazine and US News & World Reports, issues of 6/2/80.

## Living with Uncertainty: Saga of Love Canal Families

Background: Starting in the 1930s the Hooker Chemicals and Plastics Corp. had disposed of its toxic chemical wastes in metal drums in a deep, open trench--the remains of an aborted 19th century attempt to dig a canal between the Niagara River and Lake Ontario. In 1953, the company turned the site over to the Niagara Falls Board of Education, which filled the ditch and built a school on the site. The school board sold part of the property to developers who built private homes there. In the years that followed, heavy rains fell in the Niagara Falls area, the drums holding the chemical wastes began to rot, and in 1976 the chemicals made their way to the surface.

**AFTER THREE YEARS OF CONSTANT FEAR, AN ENTIRE NEIGHBORHOOD IS FLEEING TO ESCAPE THE HAZARDS OF BURIED CHEMICALS.**

**NIAGARA FALLS, N.Y.**

An emergency declared by President Carter at the site of an abandoned toxic-chemical dump here signals only stopgap relief from the growing nationwide risks of hazardous wastes.

Once a pleasant neighborhood of tree-lined streets, the Love Canal section of this industrial city is turning into a boarded-up ghost town with the exodus of 710 more families that began in late May, three years after dangerous conditions came to light.

People told their bitter stories as they prepared for an evacuation to be financed partly with federal funds released by the emergency declaration. The action was spurred by studies suggesting that residents were subject to higher rates of cancer, birth defects, miscarriages, and chromosome damage.

"I lost a baby after carrying her for nine months," says Marge Bates. "She weighed only three pounds and was still-born. My doctor couldn't explain why, after nine months, she weighed only three pounds. It had to be the chemicals."

Buried underground in leaky drums are 20,000 tons of toxic substances, including lethal dioxin....

An 8-foot-high fence surrounds the site, sealing off an empty elementary school built atop the filled-in canal and 237 homes abandoned in 1978 when the state of New York relocated families living nearest the dangerous wastes. Outside the fenced-in area are other shuttered houses deserted by families with pregnant mothers or small children who were relocated from a wider area.

"The boys used to play on a baseball diamond beside the school, and this bluish-black stuff would ooze up through the ground," reports Phyllis Whitenight, a mother of five.

She had surgery for breast cancer in 1975 and says seven cases of cancer have been discovered among her neighbors in the 15 houses on 96th Street, a few blocks from the canal.

Pesticides and other poisons dumped into the canal have polluted ground water that is seeping into basements, creating hazardous vapors. Residents were cautioned to avoid their basements after air tests in homes found the presence of 80 toxic chemicals.

"We couldn't figure out why my wife developed epilepsy when no one else in her family had ever had it," recalls Harry Tolli, a shipping clerk. "I doubted that it was the chemicals at first. But we found out they were in the water backing up in the basement through the storm sewers."

**No gardens.** Health officials, worried about possible contamination, also warned residents against eating home-grown vegetables. "We had a vegetable garden, but I had to let it rot," says Walter Mikula. "They said it was all right to live here, but don't eat the vegetables."

*U.S. News and World Report*, 2 June 1980.

# The Neighborhood of Fear

### Carter orders a further evacuation from polluted Love Canal

Robert Kott loved the small, neat home overlooking Black Creek in the southeastern corner of Niagara Falls, N.Y., a grimy industrial town near the Canadian border. In the 14 years since he acquired it the muscular chemical worker has spent thousands of hours painting, insulating, and otherwise caring for his precious property. But last week Kott called it quits, shuttering up the house and fleeing with his wife Joann and their five children, ages seven to 15. Said he: "I don't mind telling you we've been scared for a long time, scared for our lives."

So, too, were many of the Kotts' neighbors. Over 700 families in all, they live around Love Canal, the notorious, stinking chemical sewer that has become a symbol of the country's growing toxic waste problem. For the past two years, one report after another has told harrowing tales of noxious odors leaking into homes, of sinister-colored sludge seeping into basements, of children playing in potholes of pollutants and, worst of all, of abnormally high rates of miscarriages and birth defects, of nerve, respiratory, liver and kidney disorders, and of assorted cancers among the people of Love Canal.

When the nature of this toxic time bomb finally became fully understood in 1978, New York State relocated 239 families whose homes were closest to the dump (cost: $37 million).

Last week President Carter finally responded to their pleas. Following the disclosure of still another study reinforcing the residents' worst fears--that the chemical wastes may be causing genetic damage--Carter declared a state of emergency in the area, and empowered New York State and the U.S. Environmental Protection Agency to undertake the temporary relocation of 710 families. Among them: the Kotts, three of whose children show a frightening tendency toward convulsions.

*Time*, 2 June 1982.

SUMMARY/HOMEWORK

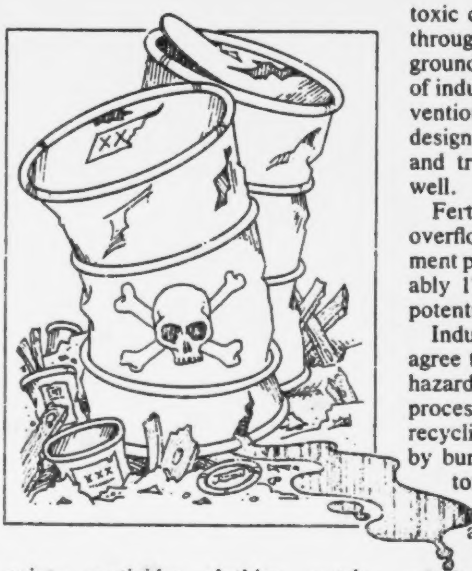
1. What caused the Love Canal emergency?
2. Why was an elementary school abandoned?
3. How effective is the high fence around Love Canal for controlling the problem?
4. Why were the residents told to avoid going into their basements?
5. Why were residents warned against growing lettuce and tomatoes in their gardens?
6. Name four health problems associated with toxic wastes.
7. Who should pay for the new homes the Love Canal residents will need? State reasons for your answer.

## LABORATORY WORKSHEET 3.8 (continued)

# Toxic wastes sites

Love Canal, N.Y., Times Beach, Mo., Valley of the Drums, Ky.—their tragedies have made them famous. Now they're synonyms for toxic-waste contamination. Unfortunately, the public-health and environmental problems posed by hazardous wastes are not restricted to just a few sites, or even a few regions of the country.

According to EPA estimates—which some environmentalists think are too low—there are at least 14,000 potentially hazardous toxic chemical dump sites across the country! More than 400 of the most dangerous sites *have* been targeted for priority cleanup under the federal government's $1.6 billion Superfund program. But recent controversy within the EPA has raised questions about how ably such cleanups are being carried out.



### What are hazardous wastes and where do they come from?

Toxic chemicals, such as dioxin, PCBs, asbestos, and lead are among the most widely publicized. But actually *any* discarded material—liquid, solid, sludge, or gas—that may pose a serious risk to public health or the environment can be considered a hazardous waste. Among the more serious potential hazards are acute and chronic health problems to human beings due to polluted air and groundwater.

Most of the waste is produced by the same industries that provide us with, among other things, plastics, paints, pesticides, clothing, metals, fertilizer, and medicines.

### How do the hazards occur?

"Midnight" dumping of hazardous wastes into sewers, on vacant lots, or along roadsides is one way. The same is true of abandoned or unmonitored dump sites, full of rusting barrels whose chemical contents ooze into the ground or surrounding waters.

Hazardous-waste landfills—areas set aside as special dump sites—can also cause problems especially when they are not sealed and lined properly with clay or plastic. In such cases water may penetrate them, mix with toxic chemicals, and eventually seep through, contaminating the underground water supplies. The dumping of industry's hazardous waste in conventional sanitary landfills—the kind designed for nonhazardous garbage and trash—is a serious problem as well.

Fertilizer and pesticide runoff and overflows of waste-storage and treatment ponds—of which there are probably 170,000 in the U.S.—are other potential sources of trouble.

Industry and environmental experts agree that it is possible to reduce the hazards by modifying the industrial processes that produce the waste; by recycling as much as 20 percent of it; by burning it up in special incinerators; by neutralizing it with other chemicals; or by reprocessing and distilling it.

Whatever the preferred method, though, the fact remains that with 80 billion pounds of hazardous waste being produced in the U.S. each year, more and safer hazardous-waste management sites are needed. Without them, hazardous wastes will continue to be dumped in inadequate facilities or in the open.

### What can you do?

If you want to find out if a dump site is on the EPA's potentially hazardous list, contact the EPA's nearest regional office. For those addresses and telephone numbers and for more information on Superfund cleanup programs, call 800-424-9346. To report spills or other emergencies where you suspect contamination, call EPA's Emergency Response Center at 800-424-8802. Contact local public-health authorities and elected officials as well.

And if a hazardous-waste site is proposed for your town, be sure to find out what kind of wastes will be accepted, how they will be transported, how close the site will be to population centers, schools, and hospitals, and who will be responsible for the site after it is closed.

In the meantime, here are some other facts you should know.

**THE NATION'S 20 WORST DUMPS**

| Location | Name |
|---|---|
| Fridley, Minn. | FMC |
| New Castle County, Del. | Tybouts Corner |
| Bruin Boro, Pa. | Bruin Lagoon |
| Woburn, Mass. | Industri-Plex |
| Pitman, N.J. | Lipari Landfill |
| Wellsville, N.Y. | Sinclair Refinery |
| Pleasantville, N.J. | Price Landfill |
| Oswego, N.Y. | Pollution Abatement Svc. |
| Charles City, Iowa | Labounty Site |
| Mantua, N.J. | Helen Kramer Landfill |
| New Castle, Del. | Army Creek |
| Old Bridge Township, N.J. | CPS/Madison Industries |
| Ashland, Mass. | Nyanza Chemical |
| Gloucester Township, N.J. | Gems Landfill |
| Coventry, R.I. | Picillo Coventry |
| Swartz Creek, Mich. | Berlin & Farro |
| Cherokee County, Kan. | Tar Creek |
| Holbrook, Mass. | Baird & McGuire |
| Freehold, N.J. | Lone Pine Landfill |
| Somersworth, N.H. | Somersworth Landfill |

## LABORATORY WORKSHEET 3.8 (continued)

# where they are and what to do

### SOURCES OF INFORMATION ON HAZARDOUS WASTE

Citizens Clearinghouse on
Hazardous Waste
P.O. Box 7097
Arlington, Va. 22207
(703) 532-6816

Citizens for a Better Environment
59 E. Van Buren, Suite 1600
Chicago, Ill. 60605
(312) 939-1530

Environmental Action Foundation
724 Dupont Circle Building
Washington, D.C. 20036
(202) 296-7570

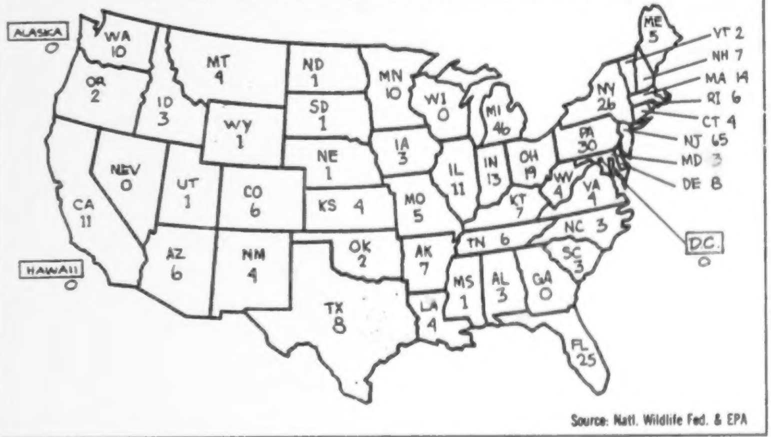
Environmental Defense Fund
1525 18th Street, N.W.
Washington, D.C. 20036
(202) 833-1484

League of Women Voters
1730 M St., N.W.
Washington, D.C. 20036
(202) 429-1965

National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036
(202) 797-6800

Sierra Club
530 Bush St.
San Francisco, Calif. 94108
(415) 981-8634

Solid Wastes Management Assoc.
1120 Connecticut Ave., N.W.
Washington, D.C. 20036
(202) 659-4613



409 MOST HAZARDOUS DUMP SITES, STATE BY STATE

Source: Natl. Wildlife Fed. & EPA

### HOW TO DETECT A "HIDDEN" DUMP SITE

Be suspicious about:

- places where nothing grows or that animals avoid
- withered or yellow patches of vegetation, especially near a landfill site
- offensive odor, taste, or color in drinking water*
- noxious fumes or an unidentifiable odor in the air
- headaches, dizziness, eye irritation, and related symptoms that occur in one location, such as where you work, but disappear when you leave
- odd behavior or physical deformities in newborn animals
- discarded barrels and drums
- death or disappearance of marine life
- neighborhood patterns of serious health problems, such as liver disease and cancer

If you think someone is breaking the law, find out what state or local agency, such as the County Health Department or State Hazardous Waste Management Office, is responsible for enforcing it, and notify the agency of the suspected violations. (Environmental Action Foundation can assist you. See resource list.)

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* However, many organic water pollutants can neither be seen nor tasted and, under present federal law, do not have to be tested for in public drinking water.

# Lesson 12: SOURCES OF HAZARDOUS WASTES

AIM: "Where do hazardous wastes come from?"

PERFORMANCE OBJECTIVES: The students will be able to:

- list the main sources of toxic wastes.
- recognize the hazards inherent in Agent Orange.
- predict that toxic waste sites throughout the country will cause problems and concern in the future.

MOTIVATION: "What is a 'midnight mover'?" ("No, it is not a disco dancer! It is someone who, during the night, illegally disposes of toxic chemicals.") "Where do these chemicals come from?"

DEVELOPMENT

1. Distribute Laboratory Worksheet 3.9.
2. Guide the students through the worksheet after they have read it.

# LABORATORY WORKSHEET 3.9

NAME______________________________ CLASS______________ DATE______________

PROBLEM: Where do hazardous wastes come from?

INTRODUCTION: Toxic chemicals have been dumped into sewers, streams, lakes, rivers, oceans, forests, fields, trenches, and even along the sides of roads. This is a national problem and happens in every state.

PROCEDURE

Examine the chart.

1. Which industry produced the least toxic waste?

____________________

2. Name the three main sources of chemical hazardous wastes in 1977.

____________________

3. How many million metric tons of waste came from the three main sources listed above?

____________________

Where Hazardous Wastes Come From

| Industry | Million Metric Tons in 1977 |
|---|---|
| Batteries | 0.164 |
| Inorganic Chemicals | 3.900 |
| Organic Chemicals, Pesticides and Explosives | 11.666 |
| Electroplating | 4.053 |
| Paint and Allied Products | 0.110 |
| Petroleum Refining | 1.841 |
| Pharmaceuticals | 0.074 |
| Primary Metals Smelting and Refining | 8.973 |
| Textiles Dyeing and Finishing | 1.870 |
| Leather Tanning | 0.143 |
| Special Machinery | 0.153 |
| Electronic Components | 0.078 |
| Rubber and Plastics | 0.944 |
| Waste oil Re-refining | 0.074 |
| Total | 34.043 |

Source: Environmental Protection Agency

"Where Hazardous Wastes Come From," in *Editorial Research Reports,* vol. 2, 1978, p. 743.

The entire chemical industry, including manufacturers of substances such as plastics, drugs, and paints, sold some $113 billion worth of products in 1977, an 11 percent increase over the previous year. By comparison, the industry sold only $13.7 billion worth of chemicals in 1947. Environmentalists, health officials, and others contend that many new chemicals come into widespread use well before toxicologists are able to determine their effects on health and the environment.

Love Canal may not be the worst toxic waste problem in New York State.

# Agent Orange

Adapted from an article written
by Robert Rickles and Harold Holzer

In Vietnam, the U.S. dropped 350 pounds
of Agent Orange's deadliest
ingredient. Today, there's a full ton
buried in upstate New York.

For eight years of the Vietnam War, American soldiers used a weapon called Agent Orange. A powerfully corrosive chemical defoliant, Agent Orange destroyed thousands of acres of Southeast Asian vegetation and agriculture--permanently.

Since then, many of the servicemen who handled Agent Orange have been claiming, in and out of court, that their own contact with the defoliant has caused them serious health problems.

A scientific task force wants to discover, once and for all, what the most dangerous ingredient in Agent Orange--the chemical dioxin--does to the human body. According to David Weir, coauthor of Circle of Poison, dioxin is "one of the most fiendishly toxic substances known."

But while attention is focused on Vietnam for these elusive answers, the Agent Orange catastrophe threatens a small area of northern New York State near Niagara Falls. There, at Hyde Park, on a sixteen-acre chemical dump site, an American corporation has buried a full ton of deadly dioxin--a quantity six times greater than the amount dropped on Vietnam.

Worse yet, recent evidence indicates that what was buried about thirty years ago may now be resurfacing. It poses great danger in the form of dioxin to five million people by seeping into the nearby Niagara Gorge, which feeds fish-laden Lake Ontario.

## LABORATORY WORKSHEET 3.9 (continued)

Experts say that the potential to poison is so great it could make Love Canal look like a poison-ivy epidemic by comparison. Not surprisingly, the company behind the Hyde Park dump is the very same firm that filled Love Canal with toxins--Hooker Chemical Corporation.

In fact, the Hyde Park landfill is the site where Hooker dumped chemicals after its Love Canal site was filled. In all, Hooker dumped some 80,000 tons of dangerous chemicals into Hyde Park between 1953 and 1974. In addition to 2000 pounds of dioxin, such carcinogens as trichloroethylene, monocholrobenzene, and hexachlorobutadiene were also buried there. In terms of both area and volume of material, Hyde Park now has one of the largest concentrations of dangerous chemicals dumped in any single site on the earth.

The Federal Environmental Protection Agency (EPA) and the State of New York have quietly negotiated an agreement with Hooker to clean up Hyde Park. Independent studies suggest that it will cost from $150 million to $250 million to clean up the dump.

Strangely, the Hyde Park time bomb received very little attention from press or public until 1978, and then quite by accident. Prior to 1978, cursory inspections by the Niagara County Health Department and the New York State Department of Environmental Conservation suggested there was very little wrong that could not easily be cured. They called for such controls as modest drainage systems, but little else.

Adapted from Rickles, Robert, and Harold Holzer "Agent Orange," *Rolling Stone*, 4 March 1982, p. 11.

# Agent Orange: What It Is and Does

By Dianne Ripley

From 1962 to 1970, a defoliant was sprayed over 5 million acres of Vietnam in a campaign called Operation Ranchhand. Its purpose was to eliminate vegetation used as camouflage by the Viet Cong and to destroy the enemy's crops and food supplies. The name given to this herbicide was Agent Orange. Chemists know it as 2,4,5-trichlorophenol, or 2,4,5-T.

The danger of 2,4,5-T lies in a byproduct of its manufacture--tetrachlorodibenzoparadioxin, or dioxin. Dioxin is an insidious contaminant said to be one of the most toxic substances known to man; its toxicity is so high that it is measured in parts per trillion rather than in parts per million. Some experts say that if three ounces of dioxin were spilled into the New York City water supply, it would be fatal to the entire city's population.

Dow Chemical Company is the major manufacturer of 2,4,5-T in the United States. Though Dow officials have maintained that the herbicide is "not significantly hazardous to human or animal life," experiments conducted on laboratory monkeys at the University of Wisconsin have demonstrated that minuscule amounts of dioxin can cause hemorrhaging, hair loss, and miscarriage.

The effects of dioxin on humans have been documented by veterans who were exposed to Agent Orange in Vietnam. Among the symptoms that have been reported are skin lesions, swollen liver, numbness of the extremities, reduced sex drive, and personality disorders. After continued pressure from those men who fought in Vietnam, the Veterans' Administration ordered a fullscale epidemiological study on its effects.

Although 2,4,5-T was used in the United States as an herbicide for more than thirty years, by 1979 the Environmental Protection Agency had suspended its use in most cases after reports of ill effects on farmers and animals. However, the herbicide can still be used to dust rice crops and rangelands and to clear vegetation from airport run-ways, vacant lots, and the like.

*Rolling Stone*, 4 March 1982.

SUMMARY/HOMEWORK

1. Why is Agent Orange dangerous?
2. Why are the chemicals buried at Hyde Park resurfacing?
3. Why is the Hyde Park dumpsite said to be even worse than Love Canal?
4. Are all chemicals dangerous? Explain your answer.
5. Prepare a report on what dioxin does to humans.

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# ADDITIONAL IN-CLASSROOM ACTIVITIES

## ESSENTIAL VOCABULARY

1. Agent Orange
2. chromosome damage
3. convulsions
4. epilepsy
5. miscarriage
6. noxious
7. pesticide
8. relocate
9. sludge
10. toxic
11. containment
12. defoliant

# Lesson 13: TOXIC WASTE DISPOSAL

AIM: "How can we get rid of toxic wastes?"

PERFORMANCE OBJECTIVES: The students will be able to:

- identify at least three forms of toxic waste.
- describe some health problems related to toxic wastes.
- evaluate alternative methods of toxic waste disposal.

MATERIALS: Newspaper and magazine articles.

MOTIVATION: "Why should you investigate thoroughly before purchasing a home near a landfill?"

1. Ask: "What are toxic wastes?" Explain that we were not always concerned with toxic wastes, which were casually dumped into landfills until recently. The publicity surrounding Love Canal brought the problem to the attention of many people. In New York City there are many landfill sites that pose potential dangers to people.

2. Tell students that health problems have occurred in people living near old dump sites. Cancer, heart disease, lung disease, and birth defects are some problems that may be related to dump sites.

3. Since we cannot eliminate toxic wastes, we must find other ways to dispose of them. Ask: "Who should make the decision on how to dispose of wastes?" "What are some alternate methods of disposal?" and "If the alternative methods are more expensive than dumping, who will pay?"

4. Ask: "What should we do about compensating victims of hazardous waste in the past, such as those who lived near Love Canal?"

5. Ask: "What role can the government play in:
    a. "supporting research?
    b. "controlling dumping by passing and enforcing laws?"

## SUMMARY

- "Write a model law on toxic waste disposal for New York City."

## FOR FURTHER THOUGHT

1. "Should we allow trucks carrying radioactive materials to drive through New York City? Remember that hospitals use small quantities of radioactive materials such as I-131 to treat some disease conditions."

2. "What are other countries doing to control toxic wastes?"

## RECOMMENDED READING MATERIAL

Holzer, Harold, "The Enemy Below," New York, February 7, 1983, pp. 42-48.

## Lesson 14: WILDLIFE REFUGES

AIM: "How important are wildlife refuges?"

PERFORMANCE OBJECTIVES: The students will be able to:

- identify at least 2 reasons why we need wildlife refuges.
- discuss the effects of pollution on wildlife refuges.

MATERIALS: Newspaper and magazine articles.

MOTIVATION: "What would happen if there were no more wild birds?"

### DEVELOPMENT

1. Choose students to present a debate on the topic: "Are wildlife refuges necessary?"

2. Explain that each team will consist of three students, two presenters and one rebutter. Allow a two-minute break to prepare the rebuttal.

3. Allow three minutes per student for each presentation in the following order:

    a. First affirmative
    b. First negative
    c. Second affirmative
    d. Second negative
    e. Negative rebuttal
    f. Affirmative rebuttal

4. The rest of the class will act as judges.

### SUMMARY

- Each student will be asked to vote and write a paragraph explaining his/her vote.

### FOR FURTHER THOUGHT

- Take a trip to Gateway National Park.

## Questions for Review

NAME___________________________________CLASS______________DATE_______________

1. Soil is important for the production of:
   a. food
   b. clothing
   c. lumber
   d. all of these

2. Rock formed by particles that are cemented together in layers is:
   a. sedimentary
   b. metamorphic
   c. igneous
   d. all of these

3. Soil erosion is slowed down most effectively by plants growing in:
   a. clay soil
   b. sandy soil
   c. humus soil
   d. iron-rich soil

4. Topsoil usually ranges in depth from a few inches to:
   a. 2 feet
   b. 15 feet
   c. 20 feet
   d. 50 feet

5. The soil in which most plants grow best is:
   a. loam
   b. sandy soil
   c. clay
   d. silt

6. The bottom layer of soil is usually composed of:
   a. clay
   b. sand
   c. broken bedrock
   d. decayed animal and plant remains

7. The changes that take place in rock as a result of changes in temperature and abrasion are collectively called:
   a. weathering
   b. sedimentation
   c. freezing
   d. bleaching

NAME_______________________________________

8. Which of the following can weather rock physically:
   a. water
   b. wind
   c. ice
   d. all of these

9. Rocks that form from cooling and solidification of molten magma are called:
   a. sedimentary
   b. igneous
   c. metamorphic
   d. schistic

10. Dust bowls, blowouts and sand dunes result mostly from the work of the:
   a. running water
   b. ice
   c. acid rain
   d. wind

11. Humus is the name given to:
   a. sandy soil
   b. small rock particles
   c. growing plants and grass
   d. decayed plant and animal matter

12. A side view of the layers of soil in an area is called:
   a. sanitary landfill
   b. soil profile
   c. toxic dump site
   d. flow chart

13. Humus:
   a. gives soil a dark color
   b. contributes minerals to the soil
   c. enables soil to absorb water
   d. all of these

14. A word that means the same as "decay" is:
   a. erosion
   b. weathering
   c. decomposition
   d. sedimentation

NAME________________________________________

15. Which sample would contain the highest amount of organic material:
    a. topsoil
    b. subsoil
    c. partially weathered rock
    d. bedrock

16. A method of waste disposal in which partially burned garbage is compacted, then buried is called:
    a. incineration
    b. sanitary landfill
    c. open-pit dumping
    d. toxic dumping

17. An advantage of a sanitary landfill is its:
    a. lack of air pollution
    b. use of reclaimed land
    c. cleanliness
    d. all of these

18. The Love Canal:
    a. is a toxic dump site
    b. is now an abandoned area
    c. has been implicated in causing cancer, birth defects and nervous system disease
    d. all of these

19. The deadly compound in Agent Orange is:
    a. hydrogen peroxide
    b. humus
    c. decayed material
    d. dioxin

20. A mixture of minerals forms a(n):
    a. element
    b. compound
    c. rock
    d. molecules

NAME______________________________________

## True or False

21. ______ A plastic cover decomposes rapidly in a landfill.

22. ______ Plants help maintain the soil.

23. ______ Immature soil contains a thick layer of humus and thin bedrock.

24. ______ The original parent rock of an area is called bedrock.

25. ______ Soil was once bedrock.

## Matching

### Column A

26. ____ rocks that change in form

27. ____ shows the different layers of soil

28. ____ a part of soil formed from decaying plants and animals

29. ____ rock constituents

30. ____ soil with A, B, and C horizons

### Column B

a. humus

b. mixture of minerals

c. mature soil

d. metamorphic

e. soil profile

## Essay

31. Compare the ability of sandy soil and clay soil to hold water.

32. Why should persons living in distant cities be concerned about soil erosion in Montana?

33. How can we reduce soil erosion?

34. Where do toxic wastes come from? Why should we be concerned about the disposal of toxic wastes?

35. What caused the Love Canal Emergency?

## APPENDIX

The following is a list of suspended or cancelled pesticides from a an EPA publication. This list should be updated periodically.

### Canceled or Suspended Pesticides

| | |
|---|---|
| Aldrin | Canceled, except for certain specified uses. |
| Arsenic trioxide | In excess of 1.5 percent, labeling which bears directions for home use is unacceptable, and a warning against home use is required. |
| Basic copper arsenate | Voluntary cancelation of all products. |
| BHC | All registered products eliminated. |
| Bithionol | Products that were intended for direct contact with skin (use in textiles) or in household use were canceled. |
| Chloranil | All products canceled voluntarily. |
| Chlordane | Registered products canceled as of December 31, 1981. Very limited use still allowed for subsurface ground insertion in termite control. |
| Chlorbenzilate | Canceled, except for citrus uses in Florida, Texas, California, and Arizona where the product has to be registered. |
| DBCP | Suspended, except can be used on pineapples in Hawaii. |
| DDD (TDE) | Canceled |
| DDT | Canceled, except limited use by U.S. public Health Service for control of vector diseases. It can be used in drugs for controlling body lice (to be dispensed only by a physician). |
| Endrin | Canceled for uses on tobacco, cotton, apple orchards, sugarcane. In places where use is still allowed female ground applicators must wear special clothing. |
| Fluoroacetamide | Labeling amended to allow use only inside of sewers against Norway and roof rats. |
| Heptachlor | Most registered products canceled by July 1, 1983. |
| Keptone | All registered products canceled May 1, 1978. |

| | |
|---|---|
| Lindane | Canceled for use in vaporizers. |
| Mercury | Very limited use as a fungicide still allowed. |
| Methaldehyde | Snail and slug bait must contain the following warning: "This pesticide may be fatal to children and dogs or other pets if eaten. Keep children and pets out of treated area." |
| Mirex | All registered products canceled December 1, 1977. |
| OMPA | Voluntary cancelation of all products. |
| 10,10 Oxbisphen-oxarsine | Product labels amended to eliminate use in windbreakers and baby pants. |
| PCB | Elimination |
| Polychlorinated terphenyl | Elimination |
| Safrole | Voluntary cancelation |
| Silvex | Suspended |
| Sodium arsenite | Unacceptable for home use if over 2 percent. |
| Sodium cyanide | Canceled and suspended. Very restricted use. |
| Strobane | Voluntary cancelation |
| Strychnine | Canceled and suspended for use in mammalian predator control. |
| 2,4,5-T | Chlorodioxin contaminants not allowed. Most use suspended. |
| Thallium sulfate | All products canceled and suspended. |
| Vinyl chloride | All pesticides containing this product, whether as active or inert ingredient, canceled or suspended. |

# UNIT 2. WATER

* **NOTE TO TEACHER**

Several topics that are included in this unit are also covered in the seventh and eighth grade science curricula. Use the pretest that follows to determine if the students already know a topic well enough to omit it from your ninth grade science course.

. What happens to the water that seeps into the earth? (Grade 7, p. 263)

. What happens when we mix different substances with water? (Grade 8, p. 1)

. How can seawater be made fit for drinking? (Grade 8, p. 35)

. How can water be purified? (Grade 8, p. 54)

. How can we speed up the evaporation of water? (Grade 8, p. 323)

. What is meant by the humidity of the air? (Grade 8, p. 326)

. How is water returned from the atmosphere? (Grade 8, p. 332)

## Pretest

NAME______________________________CLASS____________DATE_____________

1. The water table is:
   - a. the level below which the ground is saturated with water
   - b. the level above which the ground is saturated with water
   - c. the level of the bedrock
   - d. another name for sea level

2. Groundwater containing carbon dioxide reacts as an acid most readily with:
   - a. limestone
   - b. sandstone
   - c. shale
   - d. slate

3. Water vapor leaves the air by a process called:
   - a. condensation
   - b. evaporation
   - c. radiation
   - d. convection

4. The dew point at a given time is $16^{o}$ C. When the air temperature lowers to the dew point, the relative humidity is:
   - a. 0%
   - b. 30%
   - c. 60%
   - d. 100%

5. The relative humidity of an air mass will decrease if the air mass is:
   - a. cooled quickly
   - b. warmed by compression
   - c. forced over a cold air mass
   - d. lifted 15,000 feet above sea level

6. The main key to the water cycle is energy from the:
   - a. sun
   - b. clouds
   - c. wind
   - d. rain

7. Most of the Earth's water is in the form of:
   - a. water vapor
   - b. glaciers
   - c. liquids
   - d. solids

NAME________________________________

8. When air at 20°C contains all the water vapor it can hold at that temperature:
   a. the relative humidity is 20%
   b. the air is saturated
   c. the air temperature is 20 degrees above the dew point
   d. all of the above

9. When spaces between soil or rock particles fill with groundwater, the soil or rock is said to be:
   a. eroded
   b. weathered
   c. saturated
   d. evaporated

10. Groundwater creates:
   a. caves
   b. creep
   c. deltas
   d. kettles

11. Groundwater supplies are not affected by:
   a. chemical wastes
   b. salt water
   c. overpumping
   d. flash floods

12. Chlorine is added to water to:
   a. make it taste better
   b. make it sparkle
   c. prevent tooth decay
   d. destroy disease-causing germs

13. Water droplets appear on a cold glass when water vapor in the air:
   a. evaporates
   b. condenses
   c. melts
   d. vaporizes

14. In the water cycle, the rain water that soaks into the ground is mostly:
   a. transpired back into the air
   b. retained as part of the underground water system
   c. evaporated back into the air
   d. run off into rivers

NAME______________________________________

15. Since the amount of water on Earth is limited:
    a. ways of adding to the water budget must be found
    b. new water sources must be found
    c. water conservation must become a part of our lives
    d. the water cycle must be changed

16. What percent of the water on the Earth is salt water which is unusable by humans for drinking?
    a. 99%
    b. 75%
    c. 50%
    d. 1%

17. Which of the following are ways that water can become polluted?
    a. dumping untreated sewage into rivers
    b. filtering water with sand filters
    c. aerating drinking water
    d. all of the above

18. Pure water is a (an):
    a. element
    b. compound
    c. suspension
    d. mixture

19. If the amount of water vapor in the air remains constant while the temperature decreases, the relative humidity will:
    a. decrease
    b. remain the same
    c. increase
    d. be constant, then decrease

20. Clouds usually form high above the surface of the Earth because at higher altitudes:
    a. they are closer to the warm sun
    b. evaporation of water is more likely to occur
    c. the relative humidity increases
    d. the relative humidity decreases

## Lesson 1: WHAT IS WATER?

[Optional]

* **NOTE TO TEACHER:** Review Theme II, Unit 5, A "Current" Topic

AIM: "What are some characteristics of water?"

PERFORMANCE OBJECTIVES: The students will be able to:

. describe the chemical structure of water.
. perform the tests for hydrogen and oxygen.
. observe the properties of a compound and compare these to the different properties of its elements.

MATERIALS: Hoffman apparatus, two test tubes, wooden splints, matches.

MOTIVATION: Set up the Hoffman apparatus. Apply an electric current through the water; show that the water is cold. Ask: "Where are the bubbles coming from?"

DEVELOPMENT

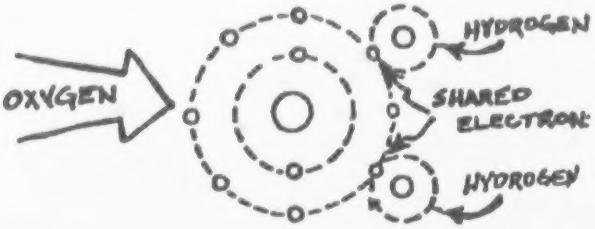
1. Demonstrate the Hoffman apparatus. (Students have studied properties of hydrogen and oxygen previously.) Allow students to identify where the oxygen, hydrogen, and water are located in the apparatus. Have them justify their answers.

2. Ask: "How do the properties of water differ from those of hydrogen and oxygen?" Define water as a compound made up of the elements hydrogen and oxygen. List the properties of water, hydrogen, and oxygen on the chalkboard.

3. Ask: "How can we test to show that oxygen and hydrogen are being produced by the Hoffman apparatus?"

   a. Using a glowing splint, test for the presence of oxygen.
   b. Using a burning splint, test for the presence of hydrogen.

4. Ask: "How can we picture the electrons in a molecule of water?" Develop the following diagram on the chalkboard:



5. Ask: "Why is water considered to be an unusual compound?" Explain that almost all liquids shrink when they freeze but water expands. A tightly sealed container filled with water may burst as the water freezes. Water pipes and car radiators are likely to burst in winter. When water at 0° C is warmed, it first shrinks until the temperature reaches 4°C then, when warmed further, the water expands. Chemically, water is a stable compound. It is a good solvent.

SUMMARY

- "Using water as an example of a compound, support the statement that the properties of a compound differ from the properties of the elements that compose it."

# Lesson 2: THE WATER CYCLE

[Optional]

AIM: "How is water cycled in the environment?"

PERFORMANCE OBJECTIVES: The students will be able to:

- describe the nature of the water cycle.
- explain that the water cycle involves the interaction of living and nonliving factors.

MATERIALS: Copies of sheets depicting the water cycle, transparency depicting the water cycle, overhead projector, Celsius thermometer, beaker, tripod, Bunsen burner, wire, gauze, glass plate, a plant in a plastic bag.

MOTIVATION: Astronauts drink their waste water several times during a space flight. Ask: "Why don't they get sick from the water?"

DEVELOPMENT

1. Set up a beaker of water on a ring stand; begin heating the water. Have one student record water temperature. Ask: "Why does the temperature stop rising when the water boils?" Review the concept of kinetic energy. Define evaporation as the process by which molecules leave the surface of a liquid when they possess enough energy.

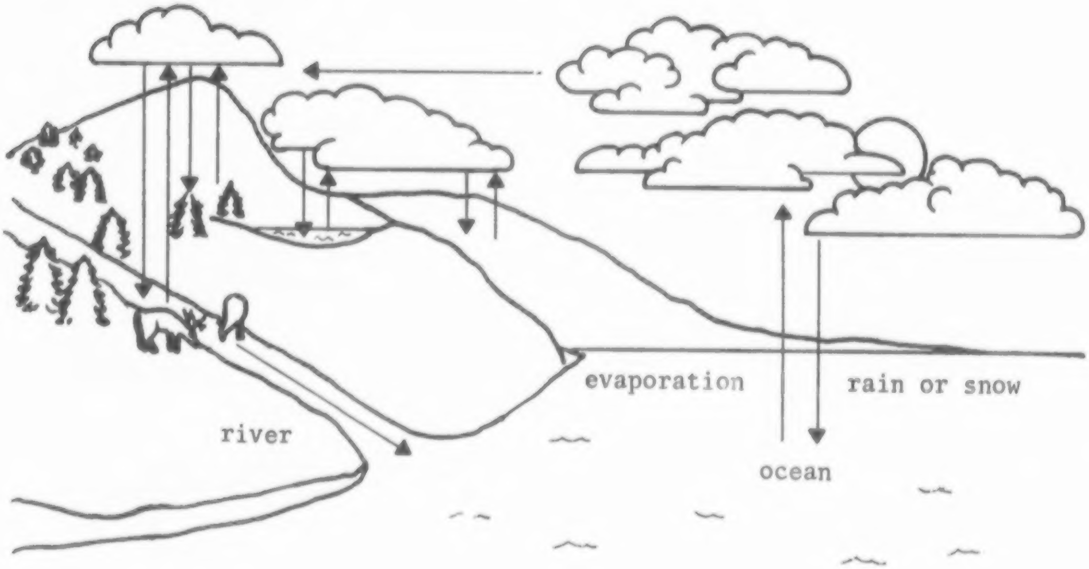
2. Using tongs, hold a glass plate over a beaker of boiling water. Ask: "Why do drops of water form on the glass plate?"

3. Display a plant that is covered by a plastic bag. Ask: "How do you account for the water droplets inside the plastic bag?"

4. Distribute the water cycle chart and display a transparency or a diagram that the entire class can see. Ask: "What is the significance of the arrows on the diagram?"

   Evaporation → transpiration → condensation → precipitation

   Explain that water evaporates from oceans to air and land and then falls back to oceans again. This movement is known as the water cycle. Sunlight falling on the ocean provides the energy for some molecules to enter the atmosphere in the form of vapor. Most of the water that has evaporated from the sea quickly returns as rain or snow. When rain falls on the land, most of it sinks into the ground or it is returned back to the ocean by rivers or streams.



The rainwater that soaks into the ground is eventually returned to the air by the action of plants through the process of transpiration.

A single drop of water may spend a few days in the air or fifty years in a glacier. It may be stored in a lake for 100 years or deep underground for thousands of years. In time a drop of water will complete the cycle.

5. Review what happens to rain when it hits the ground.

   a. Some is absorbed by plants.
   b. Some evaporates.
   c. Some runs off into rivers, lakes, and oceans.
   d. Some seeps into ground.

SUMMARY

1. "How is the sun involved in the water cycle?"

2. "Why is evaporation called the opposite of condensation?"

FOR FURTHER THOUGHT

- "How does transpiration affect the amount of water we use?"

- "How much water does the average tree return to the air by transpiration?"

# ADDITIONAL IN-CLASSROOM ACTIVITIES

## ESSENTIAL VOCABULARY

1. replenish
2. kinetic
3. evaporation
4. cycle
5. transpiration
6. condensation
7. precipitation

## Lesson 3: WATER IN THE ATMOSPHERE
[Optional]

AIM: "How does water get into and out of the air?"

PERFORMANCE OBJECTIVES: The students will be able to:

- explain why evaporation and condensation are important factors in the water cycle.

MATERIALS: Laboratory Worksheet 3.10, paper towels, wire gauze, water, hot pad, 250 ml beaker, tin pie plate, ring stand and ring, tongs, alcohol lamp.

MOTIVATION: After several days or weeks of heavy rain, rivers overflow and floods occur. Ask: "How long will it take for the sky to empty so we have no more rain?"

### DEVELOPMENT

1. Guide students through Laboratory Worksheet 3.10.
2. Caution students about using alcohol lamps. (See "Hazards and Precautions" in this curriculum guide.)

### SUMMARY

- See Worksheet 3.10.

### FOR FURTHER THOUGHT

- Explain how Freon gas is subjected to condensation and evaporation to keep a refrigerator cold.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. There are people who never drink water. How do they survive?
2. If plants do not get the proper amount of water, it affects the animal kingdom? How?
3. Why is water considered a basic resource?

### ESSENTIAL VOCABULARY

1. vital
2. environment
3. organism
4. essential
5. basic
6. resource

# LABORATORY WORKSHEET 3.10

NAME________________________ CLASS____________ DATE____________

PROBLEM: How does water get into and out of the air?

MATERIALS: Paper towels, wire gauze, water, hot pad, 250 ml beaker, tin pie plate, ring stand and ring, tongs, alcohol lamp.

INTRODUCTION: Billions of tons of water fall on the surface of the earth every year in the form of rain and snow. About 1/4 of this water runs off the land and returns to the ocean. Another portion of this water evaporates into the air and later falls again as rain. Soil and plants absorb some of the water, and the remainder soaks into the earth as groundwater. The major elements of the water cycle are the fall of rain and snow to the earth, its evaporation, and its eventual return to the earth as rain or snow.

PROCEDURE

1. Moisten the backs of each of your hands with equal amounts of tap water. Record the time.

   ____________________

2. Fan one moistened hand with cardboard until it is completely dry. How long did it take to dry? ____________

3. Was there any difference in temperature between your hands while you were fanning?

   ________________________________________

   ________________________________________

4. It took ______________ for the unfanned hand to dry.

   What process did you just observe? ____________________

   Explain why one hand dried before the other. ____________________

   ________________________________________

   What is one way to speed up drying time?____________________

   ________________________________________

## LABORATORY WORKSHEET 3.10 (continued)

5. Following your teacher's instructions, set up an alcohol lamp [USE CAUTION!], wire gauze, ring stand and ring. Fill a beaker 1/3 full of water. Light the burner and heat the water until it almost comes to a boil. Extinguish the burner.

6. Place two ice cubes in a metal pie plate. Using tongs, hold the plate over the beaker of hot water (the flame is now out) for two minutes.

7. What do you observe forming between the bottom of the pie plate and the beaker?

________________________________________________

You have just demonstrated a process that takes place on Earth. What is it called?

_________________________________

Explain why it happens. _______________________________

________________________________________________

________________________________________________

SUMMARY/HOMEWORK

1. How do evaporation and condensation change the form of water?
2. What funishes the energy that operates the water cycle?
3. Why do windows inside a car fog up when several people first get into an automobile on a cold day?

## Lesson 4: RELATIVE HUMIDITY

AIM: "How can we determine the dew point and relative humidity of the air in the classroom?"

PERFORMANCE OBJECTIVES: The students will be able to:

- explain how humidity, relative humidity, and dew point are related.
- interpret a chart to determine the relative humidity in the classroom.

MATERIALS: Laboratory Worksheet 3.11, shiny metal can, glass stirring rod, ice cubes, thermometer, beaker with water, cheesecloth, rubber band.

MOTIVATION: "It's a summer day in August. The temperature has risen to 32° C and almost everyone is hot, sticky, and uncomfortable. The next day it is also 32° C., but you don't feel as uncomfortable. Why?"

DEVELOPMENT

1. Ask: "What do we mean by humidity?"

   The amount of moisture in the air is called humidity. Humidity can be measured and expressed in various ways. Absolute humidity indicates the actual quantity of the water vapor. This quantity is almost never measured.

   Relative humidity is a comparison between the amount of moisture in the air compared with the maximum amount that the air could hold at the same temperature. Relative humidity is expressed in percent and can be measured. The air is said to be saturated when the relative humidity is 100%.

   Dew point is the temperature to which vapor must be cooled to produce saturation. This temperature can be determined with a device which cools the air until dew appears on a metal surface. Normally relative humidity is less than 100% and the dew point is lower than the air temperature.

2. Distribute Laboratory Worksheet 3.11 and guide students through it. Caution students to be careful when waving the thermometers. Make certain to use Celsius thermometer scales since the relative humidity chart is based on that scale.

3. Guide class in the use the relative humidity chart. This may require some time.

FOR FURTHER THOUGHT

- "A probe at 5000 feet above La Guardia Airport says it is raining, yet on the ground below it is not raining. Why?"

# LABORATORY WORKSHEET 3.11

NAME______________________________ CLASS_____________ DATE_____________

**PROBLEM:** What is the dew point and relative humidity of the air in the classroom?

**MATERIALS:** Shiny metal can, glass stirring rod, ice cubes, thermometers, beaker with water, cheesecloth, rubber band.

**INTRODUCTION:** As water evaporates from the Earth's surface it is stored in the air around us. Beyond a certain limit, air becomes saturated with water vapor and can hold no more. The amount of water vapor that the atmosphere can hold increases as the atmospheric temperature rises. When the air holds all the water it can, it is said to have a relative humidity of 100%. Warm air can hold more moisture than cold air. If the air is not saturated at a high temperature, it will become saturated when the temperature of air is lowered sufficiently. The excess water vapor will change to a liquid. The temperature at which this change first occurs is called the dew point.

**PROCEDURE**

1. To find the dew point of the air in the classroom do the following:

   a. Record the temperature of the air in the classroom.

   b. Fill the can halfway with water and add 2 ice cubes.

   c. Record the temperature of the water and stir gently with a glass rod for one minute. Do not stir with the thermometer.

   d. Examine the surfaces of the cans carefully. What do you see?

   ________________________________________________

   ________________________________________________

   e. Continue stirring and add more ice if necessary to lower the water temperature. Record the temperature at which you first observe condensation on the outside of the can.

   ________ °C.

   How many degrees is the dew point lower than the room temperature?

   ________________________________________________

   ________________________________________________

## LABORATORY WORKSHEET 3.11 (continued)

2. Be careful using the thermometer. To find the relative humidity of the air in the classroom do the following:

   a. Record the air temperature. __________° C. This is called the "dry bulb" reading.

   b. Wrap a piece of cheesecloth around the bulb of the thermometer and fasten it with a rubber band. Dip the cloth into water at room temperature. Fan the cloth until the temperature no longer decreases. Be careful not to touch the bulb of the thermometer. Record this temperature as the "wet bulb" reading.

      ______________°C.

   c. Subtract the two temperatures (2b from 2a) and record the difference.

      DRY BULB ______° - WET BULB ______° = ________°

   d. Using the relative humidity chart, determine the relative humidity of the air in the room.

      __________%

Differences in Temperature (°C)

| Dry-Bulb Temperature (°C) | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 94 | 88 | 82 | 77 | 71 | 66 | 60 | 55 | 50 | 44 | 39 | 34 | 29 | 24 | 20 | 15 | 10 | 6 | -- | -- |
| 11 | 94 | 88 | 83 | 78 | 72 | 67 | 61 | 56 | 51 | 46 | 41 | 36 | 32 | 27 | 22 | 18 | 13 | 9 | 5 | -- |
| 12 | 95 | 89 | 84 | 78 | 73 | 68 | 63 | 58 | 53 | 48 | 43 | 39 | 34 | 29 | 25 | 21 | 16 | 12 | 8 | -- |
| 13 | 95 | 89 | 84 | 79 | 74 | 69 | 64 | 59 | 54 | 50 | 45 | 41 | 36 | 32 | 28 | 23 | 19 | 15 | 11 | 7 |
| 14 | 95 | 90 | 85 | 79 | 75 | 70 | 65 | 60 | 56 | 51 | 47 | 42 | 38 | 34 | 30 | 26 | 22 | 18 | 14 | 10 |
| 15 | 95 | 90 | 85 | 80 | 75 | 71 | 66 | 61 | 57 | 53 | 48 | 44 | 40 | 36 | 32 | 27 | 24 | 20 | 16 | 13 |
| 16 | 95 | 90 | 85 | 81 | 76 | 71 | 67 | 63 | 58 | 54 | 50 | 46 | 42 | 38 | 34 | 30 | 26 | 23 | 19 | 15 |
| 17 | 95 | 90 | 86 | 81 | 76 | 72 | 68 | 64 | 60 | 55 | 51 | 47 | 43 | 40 | 36 | 32 | 28 | 25 | 21 | 18 |
| 18 | 95 | 91 | 86 | 82 | 77 | 73 | 69 | 65 | 61 | 57 | 53 | 49 | 45 | 41 | 38 | 34 | 30 | 27 | 23 | 20 |
| 19 | 95 | 91 | 87 | 82 | 78 | 74 | 70 | 65 | 62 | 58 | 54 | 50 | 46 | 43 | 39 | 36 | 32 | 29 | 26 | 22 |
| 20 | 96 | 91 | 87 | 83 | 78 | 74 | 70 | 66 | 63 | 59 | 55 | 51 | 48 | 44 | 41 | 37 | 34 | 31 | 28 | 24 |
| 21 | 96 | 91 | 87 | 83 | 79 | 75 | 71 | 67 | 64 | 60 | 56 | 53 | 49 | 46 | 42 | 39 | 36 | 32 | 29 | 26 |
| 22 | 96 | 92 | 87 | 83 | 80 | 76 | 72 | 68 | 64 | 61 | 57 | 54 | 50 | 47 | 44 | 40 | 37 | 34 | 31 | 28 |
| 23 | 96 | 92 | 88 | 84 | 80 | 76 | 72 | 69 | 65 | 62 | 58 | 55 | 52 | 48 | 45 | 42 | 39 | 36 | 33 | 30 |
| 24 | 96 | 92 | 88 | 84 | 80 | 77 | 73 | 69 | 66 | 62 | 59 | 56 | 53 | 49 | 46 | 43 | 40 | 37 | 34 | 31 |
| 25 | 96 | 92 | 88 | 84 | 81 | 77 | 74 | 70 | 67 | 63 | 60 | 57 | 54 | 50 | 47 | 44 | 41 | 39 | 36 | 33 |
| 26 | 96 | 92 | 88 | 85 | 81 | 78 | 74 | 71 | 67 | 64 | 61 | 58 | 54 | 51 | 49 | 46 | 43 | 40 | 37 | 34 |
| 27 | 96 | 92 | 89 | 85 | 82 | 78 | 75 | 71 | 68 | 65 | 62 | 58 | 56 | 52 | 50 | 47 | 44 | 41 | 38 | 36 |
| 28 | 96 | 93 | 89 | 85 | 82 | 78 | 75 | 72 | 69 | 65 | 62 | 59 | 56 | 53 | 51 | 48 | 45 | 42 | 40 | 37 |
| 29 | 96 | 93 | 89 | 86 | 82 | 79 | 76 | 72 | 69 | 66 | 63 | 60 | 57 | 54 | 52 | 49 | 46 | 43 | 41 | 38 |
| 30 | 96 | 93 | 89 | 86 | 83 | 79 | 76 | 73 | 70 | 67 | 64 | 61 | 58 | 55 | 52 | 50 | 47 | 44 | 42 | 39 |
| 31 | 96 | 93 | 90 | 86 | 83 | 80 | 77 | 73 | 70 | 67 | 64 | 61 | 59 | 56 | 53 | 51 | 48 | 45 | 43 | 40 |
| 32 | 96 | 93 | 90 | 86 | 83 | 80 | 77 | 74 | 71 | 68 | 65 | 62 | 69 | 57 | 54 | 51 | 49 | 46 | 44 | 41 |
| 33 | 97 | 93 | 90 | 87 | 83 | 80 | 77 | 74 | 71 | 68 | 66 | 63 | 60 | 57 | 55 | 52 | 50 | 47 | 45 | 42 |
| 34 | 97 | 93 | 90 | 87 | 84 | 81 | 78 | 75 | 72 | 69 | 66 | 63 | 61 | 58 | 56 | 53 | 51 | 48 | 46 | 43 |
| 35 | 97 | 94 | 90 | 87 | 84 | 81 | 78 | 75 | 72 | 69 | 67 | 64 | 61 | 59 | 56 | 54 | 51 | 49 | 47 | 44 |
| 36 | 97 | 94 | 90 | 87 | 84 | 81 | 78 | 75 | 73 | 70 | 67 | 64 | 62 | 59 | 57 | 54 | 52 | 50 | 48 | 45 |
| 37 | 97 | 94 | 91 | 87 | 84 | 82 | 79 | 76 | 73 | 70 | 68 | 65 | 63 | 60 | 58 | 55 | 53 | 51 | 48 | 46 |
| 38 | 97 | 94 | 91 | 88 | 84 | 82 | 79 | 76 | 74 | 71 | 68 | 66 | 63 | 60 | 58 | 56 | 54 | 51 | 49 | 47 |
| 39 | 97 | 94 | 91 | 88 | 85 | 82 | 79 | 77 | 74 | 71 | 69 | 66 | 64 | 61 | 59 | 57 | 54 | 52 | 50 | 48 |
| 40 | 97 | 94 | 91 | 88 | 85 | 82 | 80 | 77 | 74 | 72 | 69 | 67 | 64 | 62 | 59 | 57 | 54 | 53 | 51 | 48 |

## LABORATORY WORKSHEET 3.11 (continued)

3. Compare your results with those found by other groups and explain any differences.

SUMMARY/HOMEWORK

1. Why can you be uncomfortable at 32° C one day and not be uncomfortable when the temperature is 32° C on another day?
2. What factors control relative humidity?
3. How are humidity, relative humidity, and dew point related?
4. Suppose the relative humidity is 30%. What does this mean? What does it mean if the relative humidity is 100%?
5. Why does the temperature of a wet bulb thermometer fall as the wet cloth is fanned?
6. How would you expect wet and dry bulb readings to compare when the relative humidity is 100%?

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. How can we explain evaporation as a cooling process?
2. Can the dew point temperature be higher than the temperature of the air? How?
3. Why does relative humidity affect our comfort?

ESSENTIAL VOCABULARY

1. dew point
2. relative humidity
3. humidity
4. evaporation
5. saturated
6. condensation
7. fog

## Lesson 5: GROUND WATER

AIM: "What happens to water after it reaches the ground?"

PERFORMANCE OBJECTIVES: The students will be able to:

- identify impurities in water which can be removed by natural filtration (and those which cannot).
- cite reasons for changes in the height of the water table.

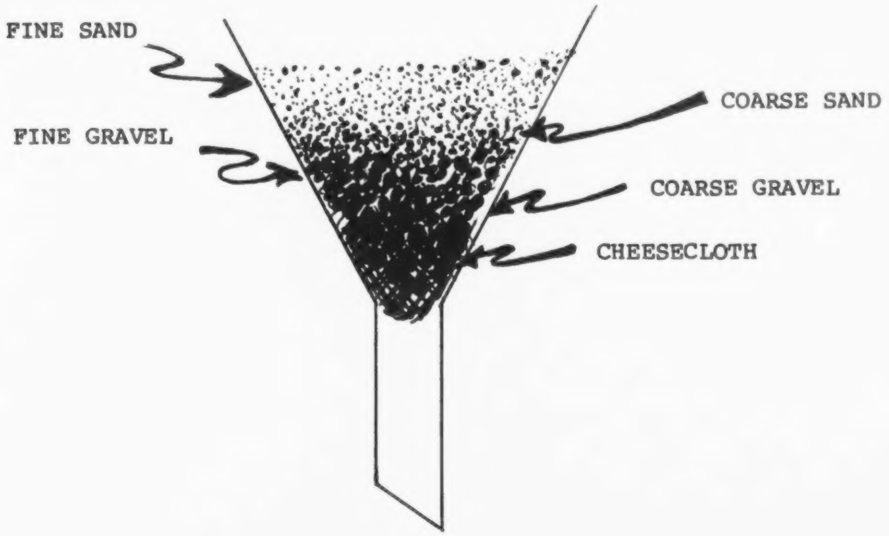
MATERIALS: Laboratory Worksheet 3.12, Funnel, ring stand, fine sand, coarse sand, fine gravel, coarse gravel, humus, clay, two 600 ml beakers, glass chimney, lift pump, ammonia, ink, dye solution or cola drink.

MOTIVATION: "A rain puddle in front of your house probably contains almost pure water. Would you like to drink it?" "If not, what would you like removed from it before you would be willing to drink it?"

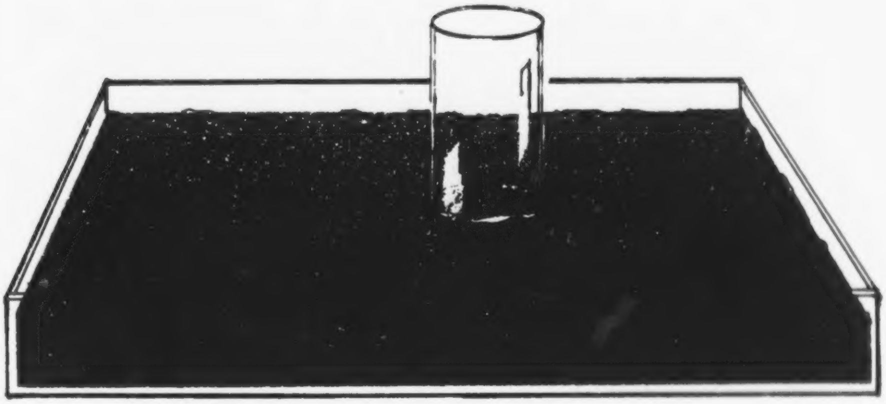
DEVELOPMENT

1. Mix a sample of puddle water in a 600 ml beaker by adding to 500 ml of tap water a teaspoon of humus or soil, a few ml of ammonia, and enough coloring to distinctly color the water. Pour the mixture through a filter you have constructed (see illustration).

2. Examine the filtrate. Ask: "Has the filter removed suspended solids (soil)?" "Has the filter removed odors (dissolved gases)?" "Has the filter removed soluble materials (dissolved dye)?"



3. Place a glass chimney inside a deep waterproof tray. Pack sand or fine gravel around the chimney until the tray is almost filled with sand or gravel. Then add water until liquid fills the lower half of the tray. (If a deep waterproof tray is unavailable, line a wooden box with a plastic sheet to make it waterproof.) The water in the tray represents the underground water in the ground and the chimney represents a well.



4. Explain that the level of the water beneath the surface of the ground is called the water table. Have students measure the distance between the surface of the sand and the level of the water in the chimney. Using a lift pump, remove water from the chimney and discard it. Then wait until water refills the chimney. Have students measure once again the distance between the surface of the sand and the level of the water in the chimney. Then have students compare the height of the water table with the original level. Ask: "What determines the time needed for the chimney to refill?" "What happens to the height of the water table as underground water is removed?" "How can we raise the height of the water table?"

# LABORATORY WORKSHEET 3.12

NAME__________________________________ CLASS_______________ DATE_______________

Read the article carefully and answer the questions that follow.

## Groundwater Pollution

More than 100 million people who drink water from underground wells may face the threat of consuming unhealthy chemical runoffs from industrial facilities or other polluting sources, a federal clean water official said on Friday.

"The problem is serious, for the intruding contaminants are often highly toxic, sometimes cancer-causing," warned Eckardt C. Beck, assistant administrator for water and waste management at the Environmental Protection Agency.

Beck told a House Government Operations subcommittee that although groundwater contamination is "very real and quite serious," there might be time to prevent further environmental damage, but action must be taken quickly.

He said that, traditionally, states bore the responsibility for groundwater, and only recently did federal statutes put EPA in the picture.

Now, he said, there are a number of federal regulations to deal with the purity of wells and other drinking water sources.

In addition, both houses of Congress are considering legislation setting up multimillion dollar "superfunds" to handle abandoned toxic waste dumps.

But Beck said the nation really needs a "coherent, integrated national approach" to get a real grip on the drinking water problem.

Beck cautioned of the severity of chemical seepage into the underground waterways.

"Our groundwaters, long considered virtually pollution-free, are threatened by ruinous contamination. The problem is national, for the potential sources and routes of contamination may be found wherever people live and work."

Beck said the pollutants originate from many places, including industrial plants, improper disposal of wastes from municipal facilities, landfills, agricultural spraying, highway deicing salts, mining, and septic tank cleaners.

"The likelihood of further deterioration nationally is clear," Beck stated, pointing out that chemicals oozing into the ground often are not cleaned out by nature, but could stay in the earth for an indefinite time -- perhaps forever.

Source: The Associated Press.

1. Why has contamination of groundwater become a serious problem?
2. Why is deterioration of groundwater supplies a problem?
3. What are some sources of groundwater pollution?
4. Choose two pollutant sources you believe to be most serious and explain why they are so serious.

# Lesson 6: SOURCES OF OUR DRINKING WATER

AIM: "Where do we get our drinking water?"

PERFORMANCE OBJECTIVES: The students will be able to:

- trace the primary sources of drinking water for New York City.
- analyze reasons for water shortages.

MOTIVATION: "Turn on the faucet; out comes a stream of clear water. How does this water get from its source to the faucet?"

DEVELOPMENT

1. Explain that the source of our drinking water depends upon where we live. In rural areas, water is pumped from wells, springs or streams. Rivers and lakes are the major sources of drinking water in this country.

2. Copy the following chart, listing the approximate amount (in gallons) of water consumed in various daily activities, onto the chalkboard:

| | | | |
|---|---|---|---|
| shower | 25 | brushing teeth | 1 |
| tub bath | 36 | toilet flush | 2-5 |
| dishwashing (tap) | 10-30 | shaving | 1 |
| dishwasher | 16 | washing clothes | 30 |
| washing hands | 2 | | |

3. Ask: "Where does New York City get its water supply?" Explain that most of the drinking water used by New York City comes from the Catskill Mountains about 160 km away, through large underground pipes, to reservoirs in upstate New York which hold water in storage (see map of New York State water supply included in this lesson). The reservoirs are artificial lakes surrounded by vast sloped areas called watersheds. The reservoirs collect water which is then piped into New York City.

4. In recent years we have experienced water shortages from time to time. Ask: "How could this have happened?" Discuss reasons for drought in this area.

5. Distribute article "A Drought Alert Is Issued for City and 25 Counties" included in this lesson. (If possible, use more recent articles.)

SUMMARY

1. "Why does the water table usually rise in the spring?"

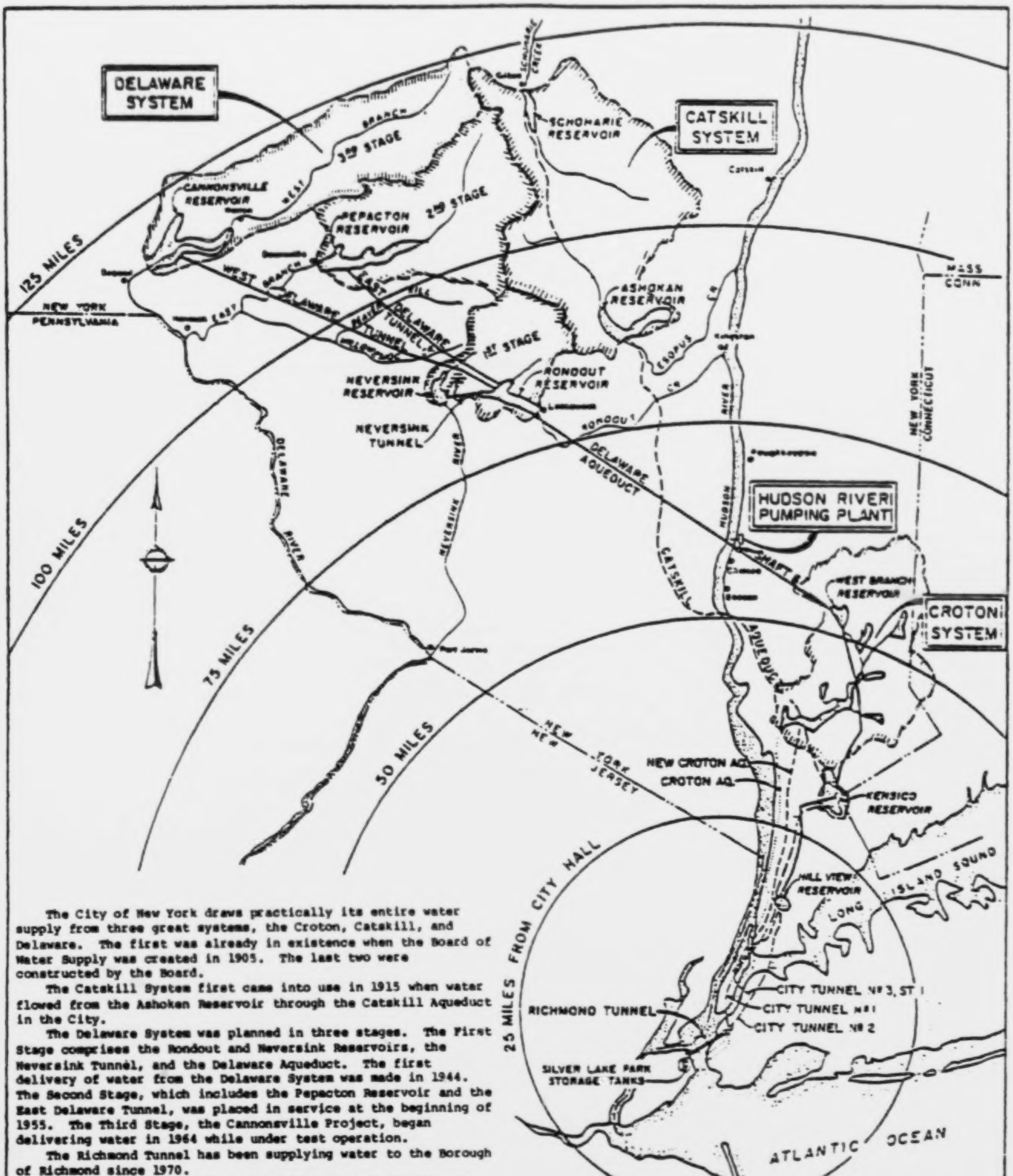
2. "What happens to the water table during a dry summer?"

3. "What effect does a drought have on New York City?"

RECOMMENDED READING MATERIAL

City of New York, Department of Environmental Protection, Bureau of Water Supply, Drought Contingency Plan.

# Water Supply of the City of New York


DELAWARE SYSTEM
CATSKILL SYSTEM
SCHOHARIE CREEK
SCHOHARIE RESERVOIR
CANNONSVILLE RESERVOIR
WEST BRANCH
3RD STAGE
PEPACTON RESERVOIR
2ND STAGE
125 MILES
NEW YORK
PENNSYLVANIA
WEST BRANCH
DELAWARE
EAST
EAST DELAWARE TUNNEL
WEST DELAWARE TUNNEL
1ST STAGE
ASHOKAN RESERVOIR
ESOPUS CR.
MASS
CONN
NEVERSINK RESERVOIR
RONDOUT RESERVOIR
RONDOUT CR.
NEVERSINK TUNNEL
NEVERSINK RIVER
DELAWARE RIVER
DELAWARE AQUEDUCT
NEW YORK
CONNECTICUT
HUDSON RIVER
HUDSON RIVER PUMPING PLANT
100 MILES
CATSKILL AQUEDUCT
SHAFT 6
WEST BRANCH RESERVOIR
CROTON SYSTEM
75 MILES
NEW YORK
NEW JERSEY
50 MILES
NEW CROTON AQ.
CROTON AQ.
KENSICO RESERVOIR
25 MILES FROM CITY HALL
HILL VIEW RESERVOIR
LONG ISLAND SOUND
CITY TUNNEL Nº 3, ST 1
CITY TUNNEL Nº 1
CITY TUNNEL Nº 2
RICHMOND TUNNEL
SILVER LAKE PARK STORAGE TANKS
ATLANTIC OCEAN
APRIL 1977

The City of New York draws practically its entire water supply from three great systems, the Croton, Catskill, and Delaware. The first was already in existence when the Board of Water Supply was created in 1905. The last two were constructed by the Board.

The Catskill System first came into use in 1915 when water flowed from the Ashoken Reservoir through the Catskill Aqueduct in the City.

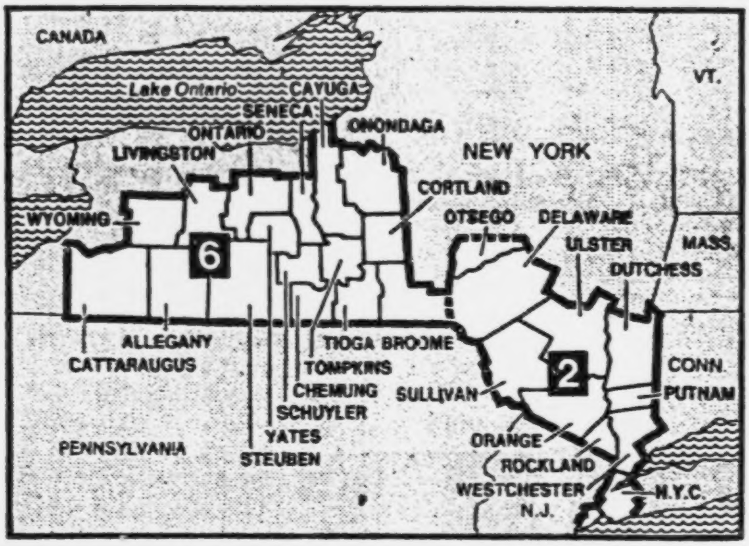
The Delaware System was planned in three stages. The First Stage comprises the Rondout and Neversink Reservoirs, the Neversink Tunnel, and the Delaware Aqueduct. The first delivery of water from the Delaware System was made in 1944. The Second Stage, which includes the Pepacton Reservoir and the East Delaware Tunnel, was placed in service at the beginning of 1955. The Third Stage, the Cannonsville Project, began delivering water in 1964 while under test operation.

The Richmond Tunnel has been supplying water to the Borough of Richmond since 1970.

City Tunnels No. 1 and No. 2 provide primary delivery of the city water supplies to and within the City; and City Tunnel No. 3 will provide additional delivery capacity.

# *A Drought Alert Is Issued for City And 25 Counties*

By WILLIAM G. BLAIR



The New York Times/Nov. 17, 1982

The two drought regions contain 28 of the state's 62 counties.

A New York State drought alert to encourage conservation in New York City and in all or part of 25 other counties was issued yesterday

The state alert followed a local advisory urging restraint in the use of water.

The advisory and alert are the mildest drought-warning categories. The most serious are a drought emergency in the city and a drought disaster in the state.

In declaring the drought alert in two regions covering almost half of the state's 62 counties, Mr. Flacke recommended the immediate updating of local drought contingency plans.

In the areas covered by the state alert, "we are going to need 16 or 17 inches of rainfall between now and Jan. 31 to get out of the drought situation," said Robert F. Cross, a spokesman for the State Environmental Department. "The chances of that are remote."

The state divides New York into six drought regions. Region 2, comprising all of 13 New York City and lower Hudson River Valley counties and a small part of Otsego County, and Region 6, comprising all of 15 Southern Tier and Finger Lakes counties and a large part of Cayuga County, are covered by the alert.

As for the city, "We have had some rainfall but not in the Delaware reservoir system, and that's where the most serious problem for the city is," said Martha M. Holstein, a deputy environmental commissioner.

### Delaware Basin Warning Issued

The city water-conservation advisory was prompted by the drought warning issued last Wednesday by the Delaware River Basin Commission. The commission also cut 120 million gallons a day from the city's normal allowance of 800 million gallons of Delaware River water.

The Delaware reservoir system normally provides about half the city's water needs. Water storage in the Delaware system dropped to 37.1 percent yesterday, compared with 39.2 percent last Wednesday.

The other half of the city's supplies comes from the Catskill and Croton reservoir systems. Between Monday and yesterday, Miss Holstein said, the water level in the Croton system had increased slightly, to 84.5 percent of capacity, and the level in the Catskill system had declined slightly, to 60.1 percent.

Mr. Cross, the state spokesman, said that Regions 2 and 6 had been put under the alert because of several drought indicators involving precipitation, soil moisture, stream flow and reservoir, lake and ground-water levels.

For example, he said, in Region 2 the precipitation deficit by the end of the first 10 months of 1982 was 5.74 inches, compared with the peak deficit of 7.80 inches in the 1981 drought. In Region 6, he said, the deficit by Nov. 1 was 5.84 inches, compared with 3.39 inches at the peak of last year's drought.

Mr. Cross said that "guesstimate" rainfall forecasts by the department's meteorologists predicted above-normal precipitation between now and Dec. 15 and below normal from mid-December to the end of January. Normal rainfall for the state, he said, would be about 3.5 inches. Snowfall, he added, "won't help in the short term, but will next spring."

*The New York Times*, 17 November 1982.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. If you live in an apartment, you do not have to pay a water bill. Do you think people living in private homes with a metered water supply are more careful with their consumption of water? Why? Do you think that if everyone had to pay separately for each gallon of water they used it would be advantageous?

2. What can you do to conserve water?

### ESSENTIAL VOCABULARY

1. reservoirs
2. artificial
3. conservation
4. watershed
5. drought

## Lesson 7: TYPES OF WATER POLLUTION

AIM: "When does water become unfit for use?"

PERFORMANCE OBJECTIVES: The students will be able to:

- recognize the fact that some bodies of water are polluted.
- identify types and sources of water pollution.
- identify an individual's role and/or responsibility in polluting water.

MATERIALS: Beaker.

MOTIVATION: Hold up a beaker full of dirty water. Tell the class that the water came from a polluted body of water. "What would you have to do to this water before safely drinking it?"

DEVELOPMENT

1. Ask: "How would you describe water pollution?" (For example, presence of undesirable materials in water.)

2. Ask: "What is responsible for water pollution?" Discuss with class and list on chalkboard, i.e.:

   a) thermal pollution
   b) animal wastes
   c) acid wastes
   d) sewage
   e) radioactive substances
   f) bacteria
   g) chemicals
   h) waste oil
   i) trash and garbage
   j) landfill debris, etc.

3. Ask: "Why are we cautioned about drinking tap water in some foreign countries?" and "How can we detect and eliminate bacterial pollution?"

4. Show pictures of a body of water that has become polluted.

5. "Why do we have more water pollution today than in 1900?"

   a. Municipal sewers in New York State contribute 40 billion gallons of effluent in various stages of treatment.

   b. Refuse from industry and agriculture (contaminated agricultural runoff -- pesticides, fertilizers).

   c. Storm runoff contains sediments and fertilizers.

   d. Storm runoff from urban areas contains street and road pollutants, e.g., oil, gasoline, pet wastes, road salts, nicotine.

   e. Inadequate domestic septic systems.

   f. Some communities still dump household sewage directly into large bodies of water. (This is now being restricted.)

## SUMMARY

1. "Why is pollution of fresh water supplies a growing problem?"
2. "How does water pollution affect our water supply?"

## FOR FURTHER THOUGHT

- "Write a composition on one of the following: What is the individual's (student's) role in:

  -- polluting water supplies?"
  -- preventing water pollution?"

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. How does water pollution affect animal life and vegetation?
2. How does water pollution affect recreational activities?
3. How are you responsible for water pollution? What can you do about it?
4. Why was water "cleaner" 25 years ago?

### ESSENTIAL VOCABULARY

1. polluted
2. impurities
3. debris
4. detect
5. pesticides
6. sediments

## Lesson 8: WATER PURIFICATION

AIM: "How can dissolved impurities in water be removed?"

PERFORMANCE OBJECTIVES: The students will be able to:

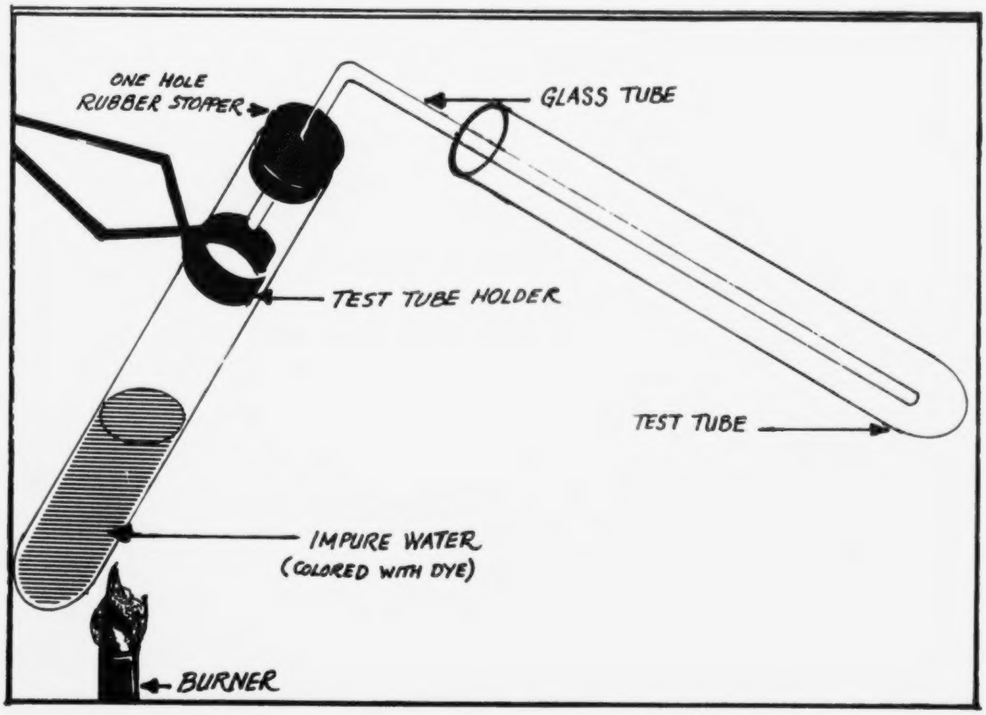
- describe a method of water purification.
- purify water by the process of distillation.

MATERIALS: See Laboratory Worksheet 3.13 or Laboratory Worksheet 3.14, test tubes, test tube rack, test tube holder, glass tube, cloth, filter paper, one-hole rubber stopper, screen, aluminum foil, clear plastic wrap, two beakers (one 600 ml), alcohol lamp, container of dirty water, coarse gravel, glass chimney, lift pump, food dye, Bunsen burner.

MOTIVATION: "A group of campers were lost in the Catskill Mountains and their canteens were empty. When they came upon a stream, they wondered whether the water was safe to drink. What could they do to make the water safe to drink?"

DEVELOPMENT

1. Ask: "How can dissolved (unfilterable) impurities be removed from water?"
2. Heat impure water until you have collected a few milliliters of colorless distillate. When the distillate is cool, examine and taste it.



3. Place a glass chimney inside a 600 ml beaker. Add coarse gravel to the beaker outside the chimney. Add water slowly to the chimney until the water is visible in the gravel halfway up the beaker. The level of soil saturated with water is known as the water table. Pump some water out of the chimney. "What happens to the water table?" Now add some dye to the chimney. "Does the dye appear in the beaker?" If not, examine at the end of the period or the following day.

## SUMMARY

1. See Laboratory Worksheet 3.13 or 3.14.
2. "What impurities may be present in impure water?"
3. "How can each be removed?"
4. "What determines the height of the water table?"

## FOR FURTHER THOUGHT

. "How do we make ocean water fit to drink?"

Potable water can be prepared by desalting seawater. Among the methods used are distillation, ion exchange, reverse osmosis and freeze separation.

Because of the expense, only small amounts of water can be purified by distillation. Distillation is the oldest and most common method of turning sea water into fresh water. Sea water is distilled by boiling it and condensing the steam.

Ion exchange. Most impurities in water are salts, consisiting of a positive ion such as $Na^+$ and a negative ion such as Cl-. These ions can be removed by passing the water containing the ions through synthetic material which exchanges the $Na^+$ ion for a $H^+$ ion and the Cl- or other negative ion for an OH- ion. The ions ($Na^+$ and Cl-) are retained on the synthetic material and replaced in solution by $H^+$ and OH-. The insoluble ion exchange material can be restored when necessary and reused.

Reverse osmosis is a way to reverse nature's normal process. Salt water is placed under pressure and water molecules are forced to pass through a thin membrane. Since only water is able to pass through the membrane, the salt is left behind. This process also removes bacteria from the salt water. This process requires little energy but very large membrane areas.

Freeze separation. When water freezes it forms ice crystals that are free of salt. The ice is then melted to obtain fresh water. This requires less energy than to distill water.

* **NOTE TO TEACHER:** If students have difficulty designing a procedure for the experiment in Worksheet 3.13, substitute Worksheet 3.14.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Why do some people drink only bottled water instead of tap water?

2. Describe the process of filtration. Would this process be enough to purify the drinking water in New York City? Why?

3. How are the following used to purify water?

   a. activated charcoal
   b. diatomaceous earth
   c. silica gel
   d. chlorine

### ESSENTIAL VOCABULARY

1. sedimentation

2. aeration

3. chlorination

4. coagulation

# LABORATORY WORKSHEET 3.13

NAME________________________ CLASS____________ DATE____________

**PROBLEM:** How can water be purified for drinking?

**MATERIALS:** Test tubes, test tube rack, test tube holder, cloth, filter paper, screen, aluminum foil, clear plastic wrap, two beakers, alcohol lamp, container of dirty water.

**INTRODUCTION:** In some parts of the world drinking water is difficult to obtain. Although there may be a supply of water nearby, it can't be used because of the impurities it contains. Today you will perform an experiment designed to purify water by removing dissolved impurities.

**PROCEDURE**

1. Design a technique, using available equipment, to make dirty water fit to drink.
    a. What pollutants might be in the water supply?
    b. What pollutants should we remove first?
2. Write the procedure that a camper should follow to do this. (There is more space for writing on the next page.)

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**PROBLEM:** How can water be purified for drinking?

**PROCEDURE**

A. ____________________________________________________________

______________________________________________________________

B. ____________________________________________________________

______________________________________________________________

C. ____________________________________________________________

______________________________________________________________

## LABORATORY WORKSHEET 3.13 (continued)

D. ____________________________________________

____________________________________________

E. ____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

____________________________________________

3. How will you know if the water is pure after treatment?

____________________________________________

____________________________________________

4. Can all pollutants be removed by the process(es) used above? Why or why not?

____________________________________________

____________________________________________

SUMMARY/HOMEWORK

1. How is the water in our reservoirs similar to the sample of water you treated in your experiment?
2. How is the water in the reservoir made fit to drink?

# LABORATORY WORKSHEET 3.14

NAME______________________________ CLASS__________ DATE________________________

**PROBLEM:** How can we purify water?

**MATERIALS:** Test tube with fitted one-hole stopper into which a right angle delivery tube about 25 cm long has been inserted, ring stand, test tube clamp, alcohol burner, 50 ml graduated cylinder, three test tubes, 250 ml beaker, 10% sodium chloride solution, silver nitrate, ink, triple beam balance.

**INTRODUCTION:** Water purification is the process of cleaning water so that it is usable. Today you will learn about one means of purifying water, distillation.

## PROCEDURE

1. With the members of your laboratory group, construct a distillation apparatus.
2. Place 10 ml of a 10% sodium chloride solution into the test tube and cap it, using a one-holed rubber stopper with a right angle tube in it.
3. Heat the test tube until almost all of the solution is gone. DO NOT BOIL UNTIL DRY. Measure the amount collected. ________________ ml. How does this compare to the amount with which you started?

   ______________________________________________________________

4. Test your distilled water with silver nitrate. Is there any salt in your distilled water? Explain.

   ______________________________________________________________

5. How can you improve your apparatus to recover more water?

   ______________________________________________________________

   ______________________________________________________________

## SUMMARY/HOMEWORK

1. Why is there a need for water purification?
2. Which impurities can distillation remove from water?
3. Why is it impracticable to use distillation for large quantities of water?

## Lesson 9: SEWAGE

AIM: "How is waste water treated?"

PERFORMANCE OBJECTIVES: The students will be able to:

- understand the need for sewage treatment.
- explain the processes involved in water treatment.
- list problems involved in sewage treatment.

MATERIALS: Laboratory Worksheet 3.15, Laboratory Worksheet 3.16, overhead projector, transparency of a sewage treatment plant.

MOTIVATION: "Do you swim at Coney Island?"

DEVELOPMENT

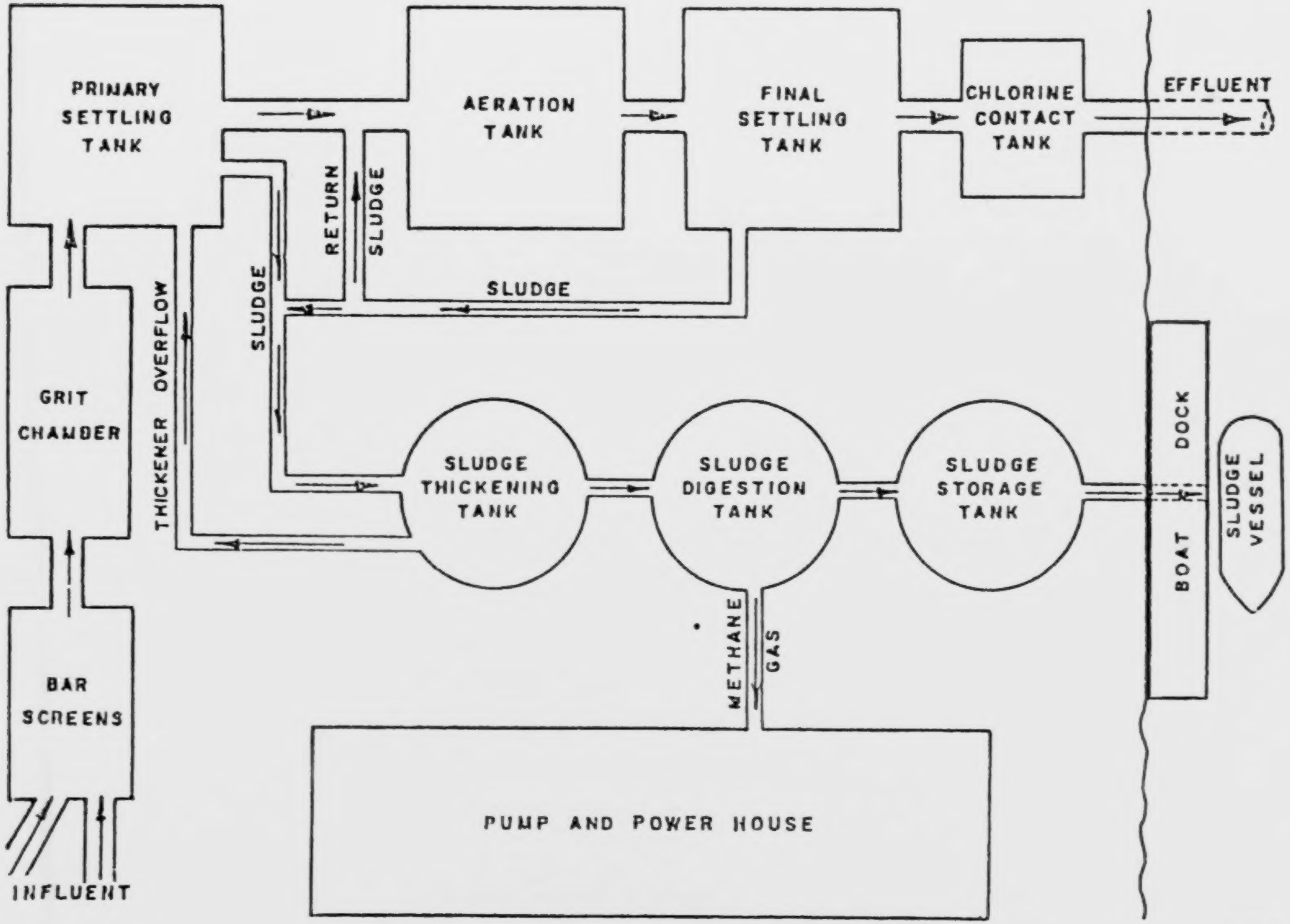
1. Ask: "What is sewage?" and "What are the sources of sewage material?"
2. Ask: "How is sewage collected?" (Sewage is collected through a system of storm and sanitary sewers.)
3. Ask: "Why is there a need for sewage treatment?" Explain that untreated sewage contains bacteria and other material harmful to health and safety, it must be treated. The goal in sewage treatment is to make it as much like potable water as possible.
4. Distribute Laboratory Worksheet 3.15, "Layout of a Typical New York City Water Pollution Control Plant." Ask: "How does a sewage treatment plant work?" Prepare a transparency of a sewage plant and display it.
5. Distribute Laboratory Worksheet 3.16, "Operation of a Typical New York City Water Pollution Control Plant." Have students read the material and answer the questions on the worksheet.
6. Ask: "Why is sewage treatment expensive?" Explain that New York City uses more than 70 million gallons of water per day. The cost of processing that part of the water that ends up in the treatment plants may be as high as five cents per 1000 gallons for just primary treatment. Secondary treatment costs ten cents per 1000 gallons and tertiary treatment may cost twenty cents per 1000 gallons.

SUMMARY

1. "What would happen if sewage was left untreated in the metropolitan area?" (pollution of South Shore beaches, shell life, Coney Island)
2. "Why is sewage treated with chlorine before it is discharged into rivers and streams?"

## LABORATORY WORKSHEET 3.15

### Layout of a Typical New York City Water Pollution Control Plant


PRIMARY SETTLING TANK
AERATION TANK
FINAL SETTLING TANK
CHLORINE CONTACT TANK
EFFLUENT
RETURN SLUDGE
SLUDGE
SLUDGE
THICKENER OVERFLOW
GRIT CHAMBER
BAR SCREENS
INFLUENT
SLUDGE THICKENING TANK
SLUDGE DIGESTION TANK
SLUDGE STORAGE TANK
DOCK
BOAT
SLUDGE VESSEL
METHANE GAS
PUMP AND POWER HOUSE

# LABORATORY WORKSHEET 3.16

## Operation of a Typical New York City Water Pollution Control Plant

Sewage is the waste water which has been polluted by home and industrial use. Until recently, the disposal of waste water was not considered to be a problem. Sewage was merely allowed to flow into the nearest body of water.

However, with a rapidly expanding population and a sharp increase in industrial wastes, the hazards of this practice became apparent. Large parts of the United States now have contaminated drinking water, disappearing marine life and water fowl, condemned bathing beaches, and the unsightly appearance of once-beautiful areas.

Water pollution control is essential now, and many systems of sewage treatment have been devised. They include septic tanks, Imhoff tanks, crushed stone trickling filters, sand filter beds, and activated sludge.

Septic tanks are widely used in areas where sufficient land is available for tank drainage and a central sewage system would be impractical. Imhoff tanks are used mainly by large institutions such as hospitals and schools which do not have access to a central sewer system.

Many cities and towns use trickling filters. These are relatively simple and effective, but require large areas that are not available in metropolitan communities such as New York City.

The choice of a sewage treatment system in a local community is determined by factors such as volume of sewage, availability of land, and the nature of the receiving waters into which the processed effluent is discharged. Circumstances dictate that the New York City plants must process large volumes of sewage with a high degree of efficiency, in very limited spaces, and often in close proximity to residential areas. These conditions can best be met by a treatment process using activated sludge. The operation of a typical New York City plant of this type is outlined below.

### PRELIMINARY TREATMENT

The treatment process begins when the raw sewage, or INFLUENT flows through the BAR SCREENS, which consist of two series of upright bars spaced about one and three inches apart. Large objects, such as rags and sticks, are removed at the bar screens by automatic raking devices. Present bar screens consist of one set of bars spaced one inch apart.

# LABORATORY WORKSHEET 3.16 (continued)

A considerable amount of sand and gravel, or GRIT, enters the city sewer system through street drains, especially during rain. It is necessary to remove this grit soon after it enters the plant to protect pumps and other equipment from abrasion, and to prevent a build-up of grit deposits in subsequent treatment tanks. In older designs a GRIT CHAMBER was used to slow the velocity of the sewage to about one foot per second. At this reduced speed the heavier particles settle and are removed from the tank by a scraping mechanism. The lighter impurities which will require additional treatment, remain suspended in the sewage flow. In upgraded plants the grit chamber is no longer used. Instead, the grit is allowed to enter the PRELIMINARY SETTLING TANK with the sewage.

## PRIMARY TREATMENT

The sewage is allowed to settle for about one hour in the PRIMARY SETTLING TANK. During this time about one-third of the suspended organic impurities settle and form a SLUDGE, which is removed from the bottom of the tank by pumps. A small amount of scum and grease rise to the top and is removed by a rotating mechanism that skims the surface. In plants where grit chambers are not present, grit settles in the primary settling tank and becomes mixed with the primary sludge. In order to separate the grit from the sludge, the mixture is pumped to a cyclone separator, where, under the action of centrifugal force and because of different specific weights, the two are separated.

## SECONDARY TREATMENT

Secondary treatment begins in the AERATION TANK, where sewage is kept from three to six hours. During this time the sewage is supplied with compressed air from diffusers near the bottom of the tank.

The purpose of the aeration tank is to convert the dissolved and suspended solids into particles which will settle in a relatively short time. It is accomplished by AEROBIC BACTERIA, which thrive in the aeration tank due to the presence of oxygen and the organic impurities in the sewage which serve as their food supply. These bacteria build up around the particles of organic matter, and then, by the process of absorption, cause the individual particles to combine into clusters. Within these clusters most of the organic matter is either consumed by the bacteria or converted into simpler, stable compounds.

The bacterial clusters in the aeration tank, called FLOC, are able to settle rapidly.

The aeration tank is followed by the FINAL SETTLING TANK, where most of the sludge that settles is removed from the bottom of the tank by pumps. After two to three hours the clarified sewage, or FINAL EFFLUENT, flows from the plant into the receiving waters.

## ACTIVATED SLUDGE

It is obvious that the number of bacteria in the aeration tank will determine the efficiency of the process. Although these bacteria multiply, they are constantly being lost as the sewage flows from the tank. As a result, unless more bacteria are added, the proportion of bacteria to suspended solids would be too low to achieve more than moderate treatment efficiency. The system of ACTIVATED SLUDGE solves this problem by returning some of the settled solids, or sludge, from the final settling tank to the aeration tank.

## TREATMENT AND DISPOSAL OF REMOVED WASTES

The 12 operating water pollution control plants in New York City process over one billion gallons of sewage each day. Thousands of tons of sludge and solid matter are removed daily, and of course it is necessary to dispose of these wastes without adding to the pollution problems.

Grit, rakings from the bar screens, and the skimmings from the primary settling tanks are carried by truck to sanitation landfills. These substances however, make up only a small fraction of the material removed. Sludge, which contains most of the impurities removed from the sewage, requires additional treatment before it is finally disposed of.

## THICKENING

In order to reduce treatment and transport costs, it is necessary to remove as much water as possible from the sludge. This is accomplished by placing the sludge in a special settling tank which is called a THICKENER. After settling for a period of 12 to 24 hours, a large amount of the water separates from the sludge. This water is returned to the sewage flow at the beginning of the plant and the remaining concentrated sludge, or THICKENED SLUDGE, is pumped from the bottom of the tank to the DIGESTER.

# LABORATORY WORKSHEET 3.16 (continued)

## DIGESTION

Because it consists of putrid solids, sludge cannot be used for landfill. Instead it is "digested" to reduce the pollution potential and is then shipped out to sea for disposal.

The DIGESTER is a large, enclosed, circular tank in which sludge is detained for a few weeks at a temperature of about 95 degrees. These conditions favor the growth of ANAEROBIC BACTERIA, which proliferate in the absence of oxygen. These bacteria obtain their nourishment by breaking down the organic compounds and in this manner convert about 50 percent of the organic matter in the sludge to various gases and water. The gas produced by digestion is composed essentially of METHANE and carbon dioxide, and many plants use it to generate all or most of their power.

The digested sludge is then pumped into a SLUDGE STORAGE TANK, where it will await shipment to sea by one of the City's four self-propelled sludge vessels. These ships, of varying capacities up to three thousand wet tons, (100,000 cu.ft.) dispose of the sludge about 12 1/2 miles out at sea, in a federally designated dumping area.

## CHLORINATION

Even the most efficient water pollution control plant does not remove all of the impurities from the sewage. PATHOGENIC BACTERIA may be present in the plant effluent, and so, during the summer months the plants disinfect their effluent in order to protect local bathing beaches from contamination.

The most effective and economical disinfectant available for sewage treatment is CHLORINE. However, in its liquid and gaseous states chlorine is extremely dangerous and difficult to handle. Therefore, since 1965, New York City plants have applied chlorine in the form of SODIUM HYPOCHLORITE, which is stored in the plant in special tanks.

Disinfection takes place in the CHLORINE CONTACT TANK, where the plant effluent is detained for an average of 30 minutes in order to insure a thorough destruction of bacteria. The plant effluent is sampled frequently during the summer in order to assess the efficiency of disinfection. About 99.999 per cent of the coliform bacteria in the final effluent are killed by hypochlorination.

Answer the following questions:

1. What is sewage? ______________________________________________

______________________________________________

## LABORATORY WORKSHEET 3.16 (continued)

2. What are some methods of sewage treatment?

3. What determines the kind of sewage treatment a community uses?

4. Briefly describe in your own words how sewage in New York City is treated.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

### ESSENTIAL VOCABULARY

1. sewage
2. sanitary
3. aquarium
4. sludge
5. compost
6. fertilizer
7. dilution
8. condemned
9. grit
10. diffusers
11. aerobic
12. activated
13. anaerobic
14. pathogenic

## Lesson 10: WATER SUPPLY PROBLEMS

AIM: "What problems might we expect to face in providing an adequate water supply for the future?"

PERFORMANCE OBJECTIVES: The students will be able to:

- construct a list of factors that would contribute to decreased water supply in the future.
- write letters to representatives in Congress suggesting support of clean water conservation.

MATERIALS: New York State map.

MOTIVATION: Place the following quote on the board:

"When the well's dry, we know the worth of water."

-- Benjamin Franklin

"What does this statement mean to you?"

DEVELOPMENT

1. Bring in an article about a recent water shortage. Ask: "Could this happen again?" and "How can we ensure that there is clean water for our future?"

2. Ask: "Why must we conserve water?"

It is estimated that each person in the United States drinks an average of 200 gallons of water each year. Each individual uses up another 15,000 gallons each year for washing, laundry, cooking, and the operation of heating and air conditioning equipment. Add to these figures, the 160,000 gallons per person used by industry per year.

| Quantity Used | Industry |
|---|---|
| 5 gallons | To process one gallon of milk |
| 10 gallons | To produce one gallon of gasoline |
| 80 gallons | To generate 1 kilowatt-hour of electricity |
| 300 gallons | To manufacture 1 pound of synthetic rubber |
| 65,000 gallons | To produce 1 ton of steel |

Add to this the billions of gallons of water needed for crops. "How much irrigation water is wasted?" "Can some irrigation water be 'grey' water?" This amounts to 13 billion gallons daily in the United States. As the population of the country grows, the demand for water will also grow. Conservation of water becomes essential. To ensure a future supply of water large enough to meet the needs of an expanding population, we need better control of water pollution.

2. Ask: "What possible new sources of water might there be in the future?" "What problems does each source bring to mind?"

3. Ask: "What have government agencies done to reduce water pollution?" Discuss the Federal Water Pollution Act of 1972.

4. Ask: "How are the laws (Federal Water Pollution Act of 1972) enforced?" Explain that individual states have primary responsibility to prevent, reduce, and eliminate pollution. The Environmental Protection Agency ensures compliance with the law.

5. Discuss the factors that can reduce or contaminate the water supply (e.g., watershed area for commercial purposes, deforestation, landfills, toxic waste sites, radioactive wastes, pesticides, recreational uses of reservoirs, household chemicals, motor oils).

6. Ask: "What could you do to waste water from your washing machine so it could be reused in your home?" and "What ideas can you suggest to decrease water consumption in your home?"

## SUMMARY

1. "How do government agencies act to control water pollution?"

2. "Why has water pollution become such a serious problem in recent years?"

3. "Write a letter to your representative in Congress suggesting legislation to ensure enough clean water for the future." Have students bring a stamped envelope to class so that the letters can be mailed.

## FOR FURTHER THOUGHT

- Write a report on one of the following topics:

  1) Desalinization
  2) Water as a byproduct of fusion
  3) Tertiary treatment of sewage
  4) Any other relevant topic approved in advance by the teacher

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Why are the oceans considered the world's largest dumps?
2. Why is radioactive material a "new" threat to our water supply?
3. Why are DDT and other insecticides causing such a problem with our water supplies?
4. What is meant by "biodegradable"?

### ESSENTIAL VOCABULARY

1. adequate
2. ensure
3. deforestation
4. pesticide
5. desalinization
6. biodegradable

# Lesson 11: ACID RAIN

AIM: "How does acid rain affect our water?"

PERFORMANCE OBJECTIVES: The students will be able to:

- identify the causes of acid rain.
- describe the effects of acid rain on plant and animal life.
- understand the experimentation being done to counteract the effects of acid rain.

MATERIALS: Laboratory Worksheet 3.17, pH test tape, three beakers, three samples of water: one with pH 7, one with pH 6, one with pH 4.5

MOTIVATION: Read the following excerpt from a magazine article: "Brooktrout Lake glistens in deathly silence. No frogs croak and nothing moves under its crystal clean surface. Twenty years ago, its serene waters gave abundant trout, bass and pickerel to any angler, but today all traces of fish have vanished." "Why did this happen?"

## DEVELOPMENT

1. Distribute Laboratory Worksheet 3.17, "Death in the Sky." Have class read the article and answer the questions on the worksheet. Discuss their answers.

   Several other articles on acid rain are suggested in this lesson. The teacher might want to choose one of these and design a worksheet to follow. Recent magazines might contain additional articles on acid rain.

2. Have three beakers of water set up, one of which is neutral (pH 7), one pH 6, and one pH 4.5. Ask: "How do we measure the acidity of water?" Review (from Science Grade 8) the meaning of pH and what we mean by the terms "acidic," "basic," and "neutral." Have student volunteers conduct tests with strips of pH paper while the class records their observations.

## SUMMARY

- "How does acid rain affect soil, forest growth, and crop yields?"

## RECOMMENDED FILMSTRIP

Acid Rain: The Choice is Ours. This can be obtained from Carolina Biological Supply Co.

## RECOMMENDED READING MATERIAL

"Acid Rain: The Choice Is Ours," available from Carolina Biological Supply Co.

"Acid Rain Report Blames Man-Made Pollution," from *Science News*, June 18, 1983, vol. 123, no. 25.

"Consensus and Controversy at NAS Acid Rain Round Table," *Science News*, July 30, 1983, vol. 124, no. 5.

Dowd, John A. "Costs without Benefits: The Rush to Judgment," from State University of New York at Buffalo Conference on Acid Rain.

"Things to Remember, Things to Ask, Things to Discuss, Things to Sort Out about Acid Rain," Coalition for Environmental-Energy Balance, P.O. Box 15026, Columbus, OH 43215.

"Acid Lakes and Thin Soils," *Science News*, May 21, 1983, vol. 123, no. 21.

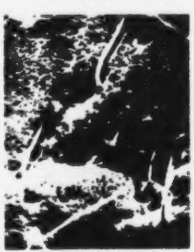
# LABORATORY WORKSHEET 3.17

**SCIENCE**

# DEATH IN THE SKY

Nestled within the spruce, pine and hemlock forests of New York's Adirondack Mountains, Brooktrout Lake glistens in deathly silence. No frogs croak and nothing moves under its crystal-clear surface. Twenty years ago, its serene waters gave up abundant trout, bass and pickerel to any angler who was willing to hike the 5 miles from the end of the nearest road, but today all traces of fish have vanished.

The fish in Brooktrout and scores of other lakes in the area were killed by acid rain—pollution produced when moisture in the atmosphere combines with oxides of sulfur and nitrogen emitted by power plants, factories and automobiles. Carried by prevailing winds, the acid clouds can jeopardize waterways, vegetation and even buildings thousands of miles from the industrial complexes that create them. Factories in Ohio and Indiana probably threaten the Adirondack lakes. An acid haze over Alaska may originate in Japan. "Acid rain is a particularly alarming demonstration of the simple adage that what goes up must come down," said Colorado Sen. Gary Hart at a recent Washington hearing. "But what comes down is worse than what went up."


Brookhaven National Laboratory

*Rain-damaged leaf*

First identified as a problem by Swedish meteorologists in the 1950s, acid rain now pours down over vast tracts of the Northern Hemisphere. Most of the precipitation that falls on the eastern U.S. is as acid as tomato juice and some as acid as vinegar. Scientists have detected high levels of acidity in Los Angeles, San Francisco, Seattle and the Rocky Mountains. Even the tropical forests of Venezuela suffer from acid rainstorms. "What we see is frightening a lot of scientists," says researcher George Hendrey of the Brookhaven National Laboratory. "It's a lot worse than we thought."

It's also unlikely to get better soon in northern America. With the U.S. commitment to more coal-fired power plants, which emit oxides of sulfur, experts fear that the rain will become even more acid. In Canada, a recent government study estimated that within twenty years 48,000 lakes will be affected by acid rain.

Ironically, acid rain results partly from efforts to reduce pollution. Two decades ago, engineers intent on minimizing local smog in industrial regions began to erect increasingly tall smokestacks; one superstack towers 1,200 feet above a copper-nickel smelter in Sudbury, Ont. "The plume goes into the air mass at a higher location, so there is less of a mix with the local air," says Stephen Gage of the Environmental Protection Agency. "But that sets the stage for the current problem by transporting the pollution several thousand miles away to deposit it somewhere else."

Scientists don't yet understand the precise mix that causes the deadly precipitation. "Both the chemical types and the rate of the reactions are controversial topics," says Hendrey. Meteorologists have similar difficulty tracing a cause-and-effect link between pollution above a specific industrial region and acid rain in a distant rural area. British scientists have just started airborne measurements to test a Scandinavian contention that acid rain over Sweden and Norway springs largely from factories in the grimy British Midlands.

Most rain is somewhat acidic.* Because it contains dissolved carbon dioxide, which converts into carbonic acid, unpolluted rain possesses a pH of 5.6. Rain in the Adirondacks falls between 4.0 and 4.5 on the pH scale—more than ten times as acid as natural rain. A team from Cornell and Yale universities monitored one storm at Hubbard Brook, N.H., with a pH of 2.85—more than 500 times the normal, and acidic enough to seriously damage vegetation.

**SHOCK:** Intensive studies of the Adirondack lakes, begun in 1975, have revealed how acid rain harms aquatic life. Rapid introduction of large amounts of acid—during the spring melting of mountain snow, for example—can boost the acidity of lakes more than tenfold in a few days. This causes a shock from which hatching fish cannot recover. "Minnows and smaller fish disappear first," says biolgist Carl Schofield of Cornell University. Ichthyologists think that the acidity interferes in some way with the fishes' gills. It also disrupts their food chain. Increased acidity replaces normal plants that live on lake bottoms and shorelines with mosses and fungi and new types of algae.

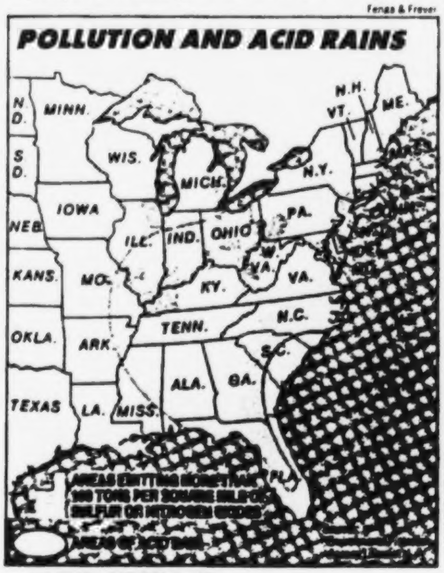
**Ecologists fear that acid rain may jeopardize more than marine life. "The potential is there for something far more serious—the possible effect on the fertility of soil," warns**

J. Goerg—N.Y. State Department of Environmental Conservation

*Attack on acid: Lacing a lake with lime*

*Danger zone: Dead fish and corroded buildings*

Fenga & Freyer



NEWSWEEK/OCTOBER 22, 1979

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*Scientists measure the acidity of rain with a criterion called pH. The scale of pH ranges from zero to fourteen; a value of seven represents the neutral point between acidity and alkalinity. The more acid the raindrop, the lower its pH. Because the scale is logarithmic, a drop of one in the pH value corresponds to a tenfold increase in acidity.

## LABORATORY WORKSHEET 3.17 (continued)

Richard Ayres of the Natural Resources Defense Council. "Thousands of square miles are undergoing loss of nutrients, washed away by the acid rain," agrees Brookhaven's Hendrey. Man-made structures, including great sculpture and architecture, are not immune to acid rain. "We don't know much yet about the corrosion of buildings," says Gene Likens of Cornell, "but economically this may be the biggest issue."

**BALANCE:** The impact of acid rain may be irreversible. Researchers are trying to reduce the acidity of lakes by dropping lime from helicopters, and they hope to breed more acid-tolerant fish. But just one thing will reduce the acid rain. "Limiting the emission of sulfur and nitrogen oxides, or eliminating them from fuel, seems to be the only way to deal with the problem," says Likens. If such a solution were achieved, it would still require years to restore the environmental balance. And few people expect even that first step to be taken anytime soon.

PETER GWYNNE with MARY HAGER in Washington and JOHN CAREY in New York and bureau reports

*Newsweek*, 22 October 1979.

1. What would be a better title for the article? Why?

____________________

____________________

____________________

____________________

2. Why might Michigan not have an area affected by acid rain?

____________________

____________________

3. Why is acid rain harmful?

____________________

____________________

4. How do scientists explain the formation of acid rain?

____________________

____________________

5. Why is the problem of acid rain getting so much attention now?

____________________

____________________

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. How does acid rain disrupt the food chain of fish?
2. Does acid rain affect the structure of buildings? How?

ESSENTIAL VOCABULARY

1. acid rain
2. abundant
3. prevailing
4. jeopardize
5. precise
6. controversial

# Lesson 12: HARD WATER

[Optional]

AIM: "How do minerals affect our water?"

PERFORMANCE OBJECTIVES: The students will be able to:

. explain that water may contain a variety of dissolved minerals.
. analyze water to determine its mineral content.

MATERIALS: Laboratory Worksheet 3.18, borax, Epsom salts, demineralized (distilled) water, tap water, hard water*, liquid detergent, four test tubes with stoppers, test tube rack, 100 ml beaker, graduated cylinder, several (3) medicine droppers, metric ruler, transparent tape, paper for labels.

* **NOTE TO TEACHER:** If natural hard water is unavailable, dissolve 1 tablespoon Epson salts in a liter of water.

MOTIVATION: Have students wash hands with soap using hard water. Have other students wash their hands with the same soap using soft tap water.** Ask: "How did the two types of water compare?" (Do this in the style of a TV commercial.)

** **NOTE TO TEACHER:** Prepare soap solution as follows: 1 cc of detergent to 9 cc of distilled water.

DEVELOPMENT

1. "How does hard water form?"

   When rain falls, it dissolves a small amount of the $CO_2$ in the air. The rain water soaks through the ground, dissolving more $CO_2$ from plant matter. If this carbonic acid solution flows over limestone ($CaCO_3$) a reaction will take place forming calcium bicarbonate. Calcium ions in solution are the greatest cause of hard water. When soap is added to hard water a curd forms. Hard water causes problems in industry. Minerals deposited by hard water will clog pipes.

2. Guide students through Laboratory Worksheet 3.18.

SUMMARY

. See Laboratory Worksheet 3.18.

# LABORATORY WORKSHEET 3.18

NAME______________________________ CLASS______________ DATE______________

PROBLEM: How do dissolved minerals affect the water we use?

MATERIALS: Borax, Epsom salts, demineralized (distilled) water, tap water, hard water, liquid detergent, four test tubes with stoppers, test tube rack, 100 ml beaker, graduated cylinder, several (3) medicine droppers, metric ruler, transparent tape, paper for labels.

INTRODUCTION: The water you use could come from either an underground source or a surface source. The type of rock the water comes in contact with will determine if the water is "hard" or "soft." Hard water contains large amounts of dissolved mineral compounds containing magnesium, calcium, and other substances. Practically speaking we can say that soft water does not contain these minerals. Today we will test how hard and soft waters affect the cleaning action of soaps.

## PROCEDURE

1. Place 25 ml of tap water (room temperature, 20°C) in a test tube; label it tube A.

2. Place 25 ml of warm tap water (40°C) in another test tube; add some borax and $Ca(HCO_3)_2$; insert stopper. Label this tube B.

3. Place 25 ml of warm tap water and some Epsom salt ($MgSO_4$ $7H_2O$) in a test tube. Label this tube C.

4. Place 25 ml of demineralized (deionized) water in a test tube. Label this tube D.

5. Place five drops of soap solution into each test tube. Place a rubber stopper in each tube and shake each test tube for 30 seconds. Measure the height of suds in the tube. In each case, record your results on the following chart. In the column on the right, rate each tube from 1 to 4 according to its sudsing power (1 = most sudsy; 4 = least sudsy).

# LABORATORY WORKSHEET 3.18 (continued)

| | Height of suds | Appearance | Rating |
|---|---|---|---|
| Tube A | | | |
| Tube B | | | |
| Tube C | | | |
| Tube D | | | |

6. Which tube was the control? ______________________________

7. Which tube contains the hardest water? ______________________

8. Which tube contains the softest water? ______________________

9. What do you conclude from this experiment? ___________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

SUMMARY/HOMEWORK

1. Why is soft water better for home use than hard water?
2. What type of water do you have at home? How can you tell?
3. Write a report on how hard water can be softened.
4. Design a follow-up experiment using: (a) different soaps, (b) varying concentrations of the same "mineral," i.e., Borax, (c) water softeners available at the supermarket, (d) a soap compared to a detergent.

## Questions for Review

NAME____________________________________CLASS______________DATE_______________

1. In the water cycle, the rain water that soaks into the ground is mostly:
   a. transpired back into the air
   b. retained as part of an underground water system
   c. evaporated back into the air
   d. run off in rivers

2. The characteristic of soil that permits a rapid flow of water is called:
   a. permeability
   b. porosity
   c. the water table
   d. groundwater

3. The level below the surface where all open spaces in soil and rock are filled with water is:
   a. permeability
   b. porosity
   c. the water table
   d. the ground table

4. Water vapor enters the atmosphere by the process of:
   a. evaporation
   b. condensation
   c. conduction
   d. radiation

5. The maximum amount of water vapor which can be held by the air at a given temperature is called:
   a. relative humidity
   b. dew point
   c. absolute humidity
   d. dew level

6. Which of the following are ways that water can become polluted:
   a. sewage wastes
   b. chemicals from industry
   c. water containing dissolved oxides of sulfur
   d. all of the above

7. Minerals that are usually found in the hard water include compounds of magnesium, calcium and:
   a. iron
   b. silicon
   c. sodium
   d. carbon

NAME________________________________________

8. If the amount of water in the air remains constant while the temperature decreases, the relative humidity will:
   a. decrease
   b. remain the same
   c. increase
   d. not be affected

9. It is difficult to wash clothes in hard water because the minerals dissolved in the water react with the soap to form:
   a. solutions
   b. precipitates
   c. gases
   d. crystals

10. Water evaporates most rapidly on days when the air is:
    a. hot, dry, and still
    b. muggy, hot, and windy
    c. hot, dry, and windy
    d. cold, dry, and still

11. If a piece of pH paper is dipped into a strong acid solution, the color change will indicate a number closest to:
    a. 14
    b. 9
    c. 7
    d. 1

12. The wise use of our natural resources is called:
    a. renewable
    b. pollution
    c. conservation
    d. endangered

13. The process by which plants give off water vapor is called:
    a. dew
    b. precipitation
    c. evaporation
    d. transpiration

14. The ability of a rock to allow liquids to enter is called:
    a. aeration
    b. permeability
    c. capillarity
    d. saturation

15. The Earth's current supply of water:
    a. has been present since the Earth was formed
    b. is being increased as liquid water forms beneath the Earth's surface
    c. is being depleted as the result of solar winds
    d. increases as ice freezes

NAME ______________________________

## Matching

Column A

16. ____ aeration
17. ____ chlorination
18. ____ coagulation
19. ____ distillation
20. ____ distilled water
21. ____ filtration
22. ____ methanal, ammonia
23. ____ hard water
24. ____ potable water
25. ____ water softening

Column B

a. water containing calcium or magnesium

b. adding a chemical to destroy harmful bacteria

c. gases formed from improper treatment of sewage

d. passing a liquid through a porous substance to remove suspended impurities

e. causing small particles to come together into larger ones with the help of chemicals

f. changing a liquid to a vapor by heating it and then condensing the vapor

g. removing calcium and certain other ions from water to prevent sticky precipitates from forming

h. nearly chemical-pure water

i. water which may contain harmless dissolved substances but is safe to drink

j. spraying water into the air to increase its oxygen content

## Essay

26. If you were given four samples of water, how would you determine which is best for washing clothes?

27. What is sewage? Why should it be treated before being dumped into our waterways?

28. How can the Earth's supply of fresh water be preserved for the future?

29. How does acid rain affect the environment?

30. How is water made potable? (drinkable)

# UNIT 3. AIR

The following topics are covered in the current Science, Grade 8 curriculum. They are considered optional for Grade 9.

- Of what is the air around us composed?
- What is the atmosphere?
- What can we find out about some of the gases in the air?
- Why does air exert pressure?
- What can we learn about air pressure?
- What are you breathing today? (air pollutants)
- What causes air pollution, and what can we do about it?

A Pretest is included so that you can determine what your students know about these topics.

## Pretest

NAME____________________________________CLASS______________DATE_______________

1. Which of the following gases always makes up less than 1 percent of the atmosphere?
   a. oxygen
   b. water vapor
   c. argon
   d. nitrogen

2. The troposphere is important because:
   a. it is where people live
   b. it is a cold layer
   c. it absorbs most of the ultraviolet rays from the sun
   d. it is a very hot layer

3. A rain cloud would most likely form in the:
   a. troposphere
   b. stratosphere
   c. ionosphere
   d. tropopause

4. The most abundant gas in the air is:
   a. oxygen
   b. nitrogen
   c. argon
   d. carbon dioxide

5. The atmosphere is sometimes heated from the bottom up because of:
   a. coriolis effect
   b. reflection
   c. conduction
   d. condensation

6. The layer of the atmosphere where most of the water vapor is found is the:
   a. ionosphere
   b. troposphere
   c. stratosphere
   d. ozone layer

7. Infrared radiation from the Earth:
   a. passes directly into space
   b. is trapped by the greenhouse effect
   c. destroys the ozone layer
   d. causes suntan

NAME______________________________

8. Nitrogen in the air:
    a. is not directly usable by plants
    b. is changed by soil bacteria
    c. comes partly from decayed plants and animals
    d. all of the above are correct

9. Most carbon monoxide comes from:
    a. the leather industry
    b. automobile exhausts
    c. cigarettes
    d. incinerators

10. Air pollution should be reduced by:
    a. using high-sulfur coal
    b. using other forms of energy for automobiles
    c. collecting polluted air and discarding it
    d. cleaning the smoke coming from industrial smokestacks

Matching

11. _____ harmful increase in water temperature

12. _____ height at which air pressure is the greatest

13. _____ pollutant produced when coal is burned

14. _____ line connecting points that have the same air pressure

15. _____ layer of atmosphere where weather is found

a. sulfur oxide

b. thermal pollution

c. ozone

d. troposphere

e. isobar

f. sea level

# Lesson 1: COMPOSITION OF AIR

[Optional]

AIM: "How is the air in Denver different from the air in New York?"

PERFORMANCE OBJECTIVES: The students will be able to:

. explain that air is a mixture of gases.
. test for the four principal components of air.

MATERIALS: 20 cm length of wire, bottle (containing air), bottle of oxygen (prepare before time by using $MnO_2 + H_2O_2$), flashlight or projector, bottle of $CO_2$ (prepare before time from marble chips + HCl), wood splints.

MOTIVATION: "A New Yorker gets off a plane in Denver, runs for a cab and collapses. What is a characteristic of Denver's air that may have caused the New Yorker to have a problem?"

## DEVELOPMENT

1. Review the meaning of the term "mixture." Air is a mixture of several gases. Relate the meaning of the term mixture to the motivation. The composition of the air varies slightly from place to place.

2. Ask: "What gases are present in the air?" List the gases and the amounts of each on the chalkboard:

Average Composition of Clean, Dry Air

| Gas | Percent by Volume |
|---|---|
| nitrogen | 78% |
| oxygen | 21% |
| argon | 0.94% |
| carbon dioxide | 0.03% |
| helium | 0.01% |
| neon | 0.01% |
| xenon | 0.01% |
| krypton | 0.01% |
| methane | trace |
| ammonia | trace |
| hydrogen sulfide | trace |
| carbon dioxide | trace |
| nitrous oxide | trace |

Water vapor varies greatly above different regions of the Earth. It ranges from .01% to about 4% by volume.

3. Burn steel wool in air and then in pure oxygen. Have students compare the rates of burning. Explain how nitrogen works as a diluting agent in the atmosphere.

4. Ask: "How can we show that carbon dioxide does not support combustion?" Have a bottle of carbon dioxide prepared (use marble chips and dilute hydrochloric acid). Pour $CO_2$ over a burning candle in a beaker.

5. Ask: "Why does the amount of water vapor in the atmosphere vary?" The humidity varies because of imbalances in the rates of evaporation and precipitation.

6. Ask: "What materials besides gases are present in the air around us?" Smoke particles, dust, and pollen are found in the air. Demonstrate that dust is present by projecting a beam of light across a dark room.

## SUMMARY

1. "Why do we call air a mixture of gases?"

2. "What is meant when people say that the air is getting dirtier?"

3. "Why is the air in the country getting dirtier and dirtier?"

4. "Explain the difference between air and oxygen."

## FOR FURTHER THOUGHT

1. "What would happen if someone tried to have dinner by candlelight in a room full of pure oxygen?"

2. "Why don't astronauts breathe pure oxygen inside their spacecraft?"

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. "We live at the bottom of an invisible ocean." Explain this statement.
2. Nitrogen makes up 78% of the Earth's atmosphere. How is nitrogen utilized on Earth?
3. How do we know that the composition of our atmosphere is changing?

## Lesson 2: STRUCTURE OF THE ATMOSPHERE
[Optional]

AIM: "How far up does the air extend?"

PERFORMANCE OBJECTIVES: The students will be able to:

- describe the structure of the atmosphere.
- explain the statement: "We live at the bottom of an ocean of air."

MATERIALS: Overhead projector, transparency showing atmosphere layers (fill in the names of the layers as you go over them with the class). Each student should also have a diagram without labels.

MOTIVATION: Explain the statement: "We live at the bottom of an ocean of air."

DEVELOPMENT

1. Ask: "Where is the atmosphere?" The ocean of air that surrounds the Earth is called the atmosphere. This blanket of air extends outward approximately 900 kilometers.

2. Ask: "What would the Earth be like without an atmosphere?" Have students write a paragraph to answer this. Have several read their answers aloud.

    a. Without air, the temperature on Earth would be about 110° C during the day and -150° C at night.

    b. The ozone layer of the atmosphere is needed for protection against the lethal ultraviolet rays of the sun.

    c. Oxygen is needed for respiration.

    d. Carbon dioxide is needed by green plants for photosynthesis.

3. Ask: "Where is the air surrounding the Earth most heavily concentrated?"

    Air molecules are most heavily concentrated at the surface of the Earth. This is due to the pull of gravity. As the altitude increases, the concentration of air molecules decreases. Ninety-five percent (95%) of all life on Earth is supported by an atmosphere layer less than 3.2 kilometers thick. At an altitude of 9.6 kilometers humans cannot obtain enough oxygen. At an altitude of 19.2 kilometers there is not enough air to support a burning candle.

4. Ask: "What are the layers of the atmosphere?" Distribute outline charts showing the atmosphere layers. Use the overhead projector.

   a. The layer that is closest to the Earth's surface is the troposphere. This layer is the lowest part of the atmosphere. The temperature decreases with an increase in altitude.

      The air is warmed near the Earth's surface; the warm air rises and gradually cools. The troposphere is about 10 kilometers thick. Ask: "Why is temperature highest near the surface of the Earth?" (Air is warmed near the Earth's surface. Warm air rises and gradually cools.)

   b. The layer above the troposphere is the stratosphere. It is a stable layer with some upward and downward air movements. It is about 20 kilometers thick. This layer contains an ozone layer that filters out the intense ultraviolet rays of the sun.

   c. Above the stratosphere is the mesosphere. Here, the air is very thin. This layer is about 40 kilometers thick but only contains about one percent of the air.

   d. Surrounding the mesophere is the ionosphere. This layer absorbs gamma rays and X-rays from the sun. Discuss its importance in sending out radio waves.

## SUMMARY

1. "Which layer of the atmosphere is most important to us?" "Explain your answer."

2. "If the ozone layer were destroyed, clams and oysters might survive, but humans would have difficulty. Why?"

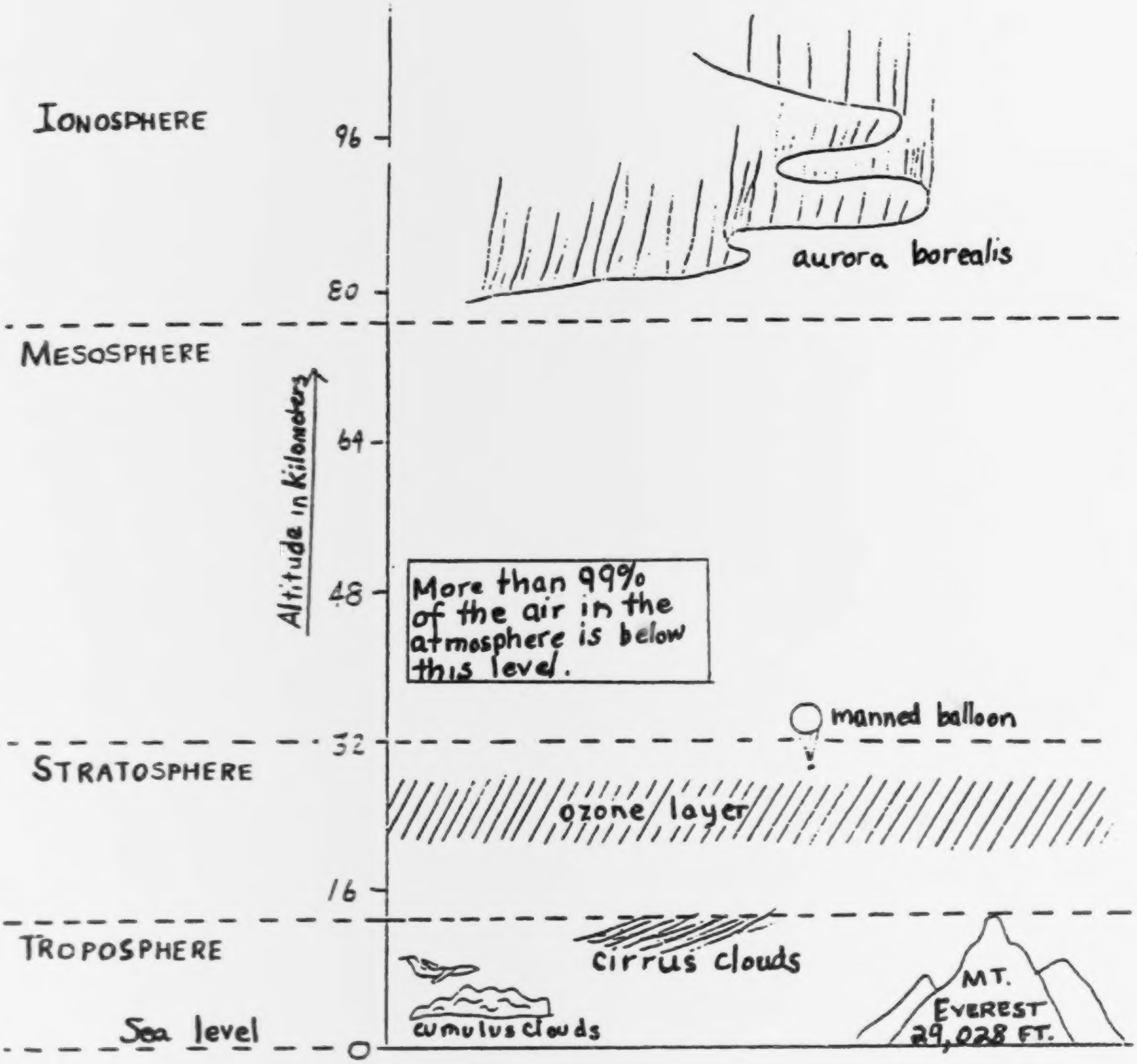
3. "Explain the statement: 'We live on an ocean of air.'"

## FOR FURTHER THOUGHT

1. "Describe the effect of human activity on the ozone layer."

2. "Which human activity presents the greatest threat to the ozone layer?"

# Layers of the Atmosphere


IONOSPHERE
96
aurora borealis
80
MESOSPHERE
Altitude in Kilometers
64
48
More than 99% of the air in the atmosphere is below this level.
32
manned balloon
STRATOSPHERE
ozone layer
16
TROPOSPHERE
cirrus clouds
cumulus clouds
MT. EVEREST 29,028 FT.
Sea level
0

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. How does each layer of the atmosphere help to serve man?
2. List several sources of dust particles in the atmosphere.

### ESSENTIAL VOCABULARY

1. lethal
2. ultraviolet rays
3. photosynthesis
4. troposphere
5. stratosphere
6. mesosphere
7. ionosphere
8. gamma rays

## Lesson 3: AIR PRESSURE
[Optional]

AIM: "Why does air exert pressure?"

PERFORMANCE OBJECTIVES: The students will be able to:

. relate air pressure to the ocean of air.
. explain why air pressure exists.
. demonstrate that air has weight.

MATERIALS: Magdeburg hemispheres, cup, equal arm balance, index card, water, football or basketball bladders, air pump, two empty 2-liter plastic soda bottles, barometer.

MOTIVATION: Fill a glass to the brim with water. Cover the opening with an index card. Press the card in slightly to remove all the air. Invert the cup quickly. "Why doesn't the water spill out?"

DEVELOPMENT

1. Ask: "How can we show that air has weight?" Use an equal arm balance to balance two collapsed football or basketball bladders. Fill one with air and replace it on the balance. Ask: "Which one is heavier?" "Why?"

2. Ask: "What do we mean by the term 'air pressure'?" We are surrounded on all sides by a sea of air that is exerting pressure in all directions. Demonstrate Magdeburg hemispheres by having two strong students try to pull them apart. CAUTION: Each student should be backed up by another to prevent injury should the hemispheres separate suddenly.

3. Ask: "How is air pressure measured?" Exhibit a barometer. Pressure is defined as the force per unit area exerted on any plane surface. The standard height of a column of mercury at sea level is 76.0 cm. Changes in the height of the mercury column reflect changes in air pressure. Weather forecasters often report surface air pressure in units called millibars. Standard sea level air pressure is 1013 millibars (mb) which is approximately equal to that of 30 inches of mercury.

4. Ask: "What happens to air pressure as height (altitude) increases?" The higher you are in the atmosphere the fewer the number of molecules above you. Therefore, the weight and pressure are less.

## SUMMARY

1. "How does the air pressure in Denver compare with the air pressure in New York City?"

2. "Why is air pressure greater at the bottom of a coal mine than at sea level?"

3. "What use does an airplane pilot make of air pressure?"

## FOR FURTHER THOUGHT

1. "What relationship exists between changing barometer readings and the weather?"

2. "Why isn't water used inside a barometer instead of mercury?"

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Why does the amount of red blood cells in your body increase if you climb a mountain?
2. Why is an airplane pressurized?
3. If air has weight, how come we don't feel the weight of the atmosphere pressing our bodies?

### ESSENTIAL VOCABULARY

1. air pressure
2. surrounded
3. exerting
4. barometer

## Lesson 4: BAROMETERS
[Optional]

AIM: "How can we measure air pressure?"

PERFORMANCE OBJECTIVES: The students will be able to:

. construct an aneroid barometer.
. use the barometer to measure air pressure.

MATERIALS: Laboratory Worksheet 3.19 and listed materials, aneroid barometer.

MOTIVATION: Display a barometer. Ask: "How is a barometer used to forecast the weather?"

### DEVELOPMENT

1. "How does a mercury barometer work?"

(Explain the principles of a mercury barometer but DO NOT MAKE A DEMONSTRATION MODEL. Handling liquid mercury is dangerous because absorption through the skin can cause mercury poisoning.)

A long glass tube that is open at one end is filled with mercury. The tube is placed, open end down, in a dish. Some of the mercury flows out of the tube into the dish. The pressure holds the column of mercury at a certain height inside the tube. If the air pressure decreases, the column of mercury will fall. If the air pressure increases the column of mercury will rise.

The standard height of a column of mercury at sea level is 76.0 centimeters. Changes in the height of the column of mercury are useful in predicting weather changes. A falling barometer often means rain. A rising barometer indicates fair weather.

Weather forecasters often report air pressure in units called millibars. Millibars indicate how much the air actually presses on the surface of the earth. Standard sea level air pressure is 1013.25 millibars.

2. Guide students through Laboratory Worksheet 3.19.

### SUMMARY

. See Laboratory Worksheet 3.19.

### FOR FURTHER THOUGHT

1. "How are mercury and aneroid barometers different?"

2. "What is the etymology of the word 'aneroid'?"

# LABORATORY WORKSHEET 3.19

NAME______________________________ CLASS______________ DATE______________

**PROBLEM:** How is air pressure measured?

**INTRODUCTION:** A barometer is an instrument that is used to measure air pressure. The aneroid barometer consists of a metal box with a thin corrugated cover, from which most of the air has been removed. When air pressure increases, it pushes the top of the box downward, causing the pointer to move in one direction. When air pressure decreases, the top of the box moves upward, causing the pointer to move in the opposite direction. Today we will construct an aneroid barometer.

**MATERIALS:** Construction paper (28 cm x 21.5 cm), coffee can (empty), plastic drinking straw, plastic wrap (16 cm x 16 cm), large rubber band, transparent tape, rubber sheet or balloon.

## PROCEDURE

1. Cut and prepare a piece of construction paper as shown in diagram A to provide a gauge by which changes in air pressure can be measured.
2. Mark the edge of the paper as shown. These marks should be 2 mm apart. Write the words HIGH and LOW on the paper as indicated.
3. Cover the top of an empty coffee jar or can with a rubber sheet (a balloon may be used). Secure this with a rubber band.
4. Attach the construction paper and coffee can as shown in diagram B.
5. Flatten one end of a plastic straw to act as a pointer. Gently tape it to the center of the stretched cover of the can.
6. Record the movements of the straw at various points in the building:

Basement ________________________

Second floor ________________________

First floor ________________________

Third floor ________________________

If the temperature is kept constant, the straw should move in response to changes in air pressure. When the straw moves downward the pressure is decreasing. When the straw moves upward the pressure is increasing.

## LABORATORY WORKSHEET 3.19(continued)

7. Record the air pressure in the classroom ____________________

   Record the air pressure in the classroom the next day ____________

   Was there a difference? If so, can you explain why?

   ______________________________________________________________

   ______________________________________________________________

SUMMARY/HOMEWORK

1. Explain the principle of the barometer.
2. Why does the air pressure differ in various parts of the building?
3. What kind of weather is generally associated with high pressure?

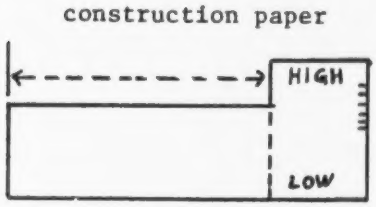
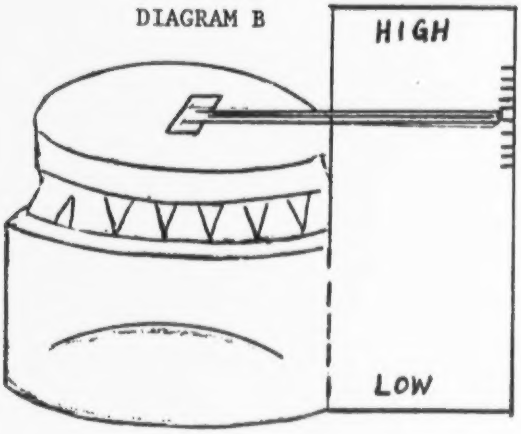


DIAGRAM A

DIAGRAM B



## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. How does an increase of temperature affect the readings of an aneroid barometer?
2. What makes rocket travel easier than airplane travel in terms of air pressure?
3. Why is life above 6000 meters difficult?
4. Bring in a daily weather map in a newspaper. Look for the measurements of pressure. How are they illustrated?

### ESSENTIAL VOCABULARY

1. mercury barometer
2. corrugated
3. transparent
4. gauge
5. aneroid barometer

# Lesson 5: ATMOSPHERIC POLLUTION

AIM: "How is air pollution produced?"

PERFORMANCE OBJECTIVES: The students will be able to:

- define the term "pollution."
- identify the source of major forms of pollution.
- analyze the effects of pollution in the environment.
- understand how air pollution is produced.

MATERIALS: Flashlight or projector.

MOTIVATION: "How much dust falls on New York City every day?" (List pupil responses and then supply the correct answer: 600,000 kilograms of dust. This weighs about 1,300,000 pounds.)

DEVELOPMENT

1. Ask: "What is air pollution?" Define air pollution as the addition of any substance to the air that is harmful to living things and their surroundings.

2. "Who is responsible for polluting the environment?"

   a. transportation ----- 78 million tons
   b. industry ---- 25 million tons
   c. utilities ---- 15 million tons
   d. heating ---- 12 million tons

3. Shine a flashlight or a projector beam across a darkened room. Have students observe the particles of dust that float in the beam. Ask: "When we breath, what keeps these harmful particles from clogging our lungs?"

4. "What is a pollutant?" A pollutant is any substance that adversely affects a biotic or an abiotic factor in the environment, provided that the substance is in sufficient concentration to produce a harmful effect.

5. "How are pollutants produced?"

   Air pollution occurs as the result of three basic factors: surface friction, vaporization and combustion.

   a. Surface friction -- small pieces of matter become suspended in the air. These small pieces of matter are referred to as particulate pollution.

   b. Vaporization (evaporation) - sources of such pollution include fast-drying paints, glues, etc.

c. Combustion (burning) -- complete combustion yields carbon dioxide and water vapor. Not all combustion is complete, due to insufficient air or fuel. Incomplete combustion produces soot, $CO_2$, CO, water vapor and hydrocarbons. Many fuels are not pure. Upon burning they produce such contaminants as nitrogen oxides, sulfur dioxide, lead and fluorides.

6. "What are some other sources of air pollution?"

| Industry | Motor Vehicles | Burning | Natural Sources |
|---|---|---|---|
| power plants | fuel exhaust | furnaces | forest fires |
| oil refineries | | incinerators | volcanoes |
| metal refineries | | | windswept desert areas |
| chemical plants | | | |

7. Distribute Laboratory Worksheet 3.20. Guide students through the questions.

## RECOMMENDED READING MATERIAL

It Stacks Up, State Department of Environmental Conservation, July 1981.

# LABORATORY WORKSHEET 3.20

NAME________________________________ CLASS_____________ DATE______________

PROCEDURE

Read this passage about the effects of air pollution and answer the questions that follow.

## The Effects of Air Pollution

A simple definition for air pollution is "man-made contamination of the environment." Air pollution has significant negative effects on all forms of living and non-living things.

The effects of air pollution may be very quick and apparent, such as deaths caused by a single dose of poison gas. They may also be the result of continuous extended exposure such as a form of lung cancer caused by asbestos. These effects are particularly insidious, since they may occur years after the exposure.

Frequently, pollution from two or more sources in combination have an effect much greater than the sum of their individual effects. An example of this synergistic effect is that both ozone and nitrous oxide are pollutants that can irritate our lungs. When these two are inhaled together, the results can be disastrous.

When we think about the effects of pollution, we are usually concerned primarily about the effects on human health. Such effects range from heavy smog causing respiratory distress or even death to the general population, to the effect of carbon monoxide poisoning upon a single individual. Often the time and degree of exposure will determine the extent of the damage to health.

Besides physical illness and death, there are other effects that are just beginning to be described and studied. Among these are the psychological effects of unpleasant living conditions and the possible genetic effects of radiation or toxic chemicals.

Damage to other living things is no less serious. Death and disease of livestock, crops and forests is not only an economic loss, but diminishes world resources, including the crucial food supply in developing nations.

## LABORATORY WORKSHEET 3.20 (continued)

Pollution also has an adverse effect on structural materials. Most metals corrode faster in a polluted environment. For example, steel corrodes 30 times as fast. Stone buildings are literally dissolving and valuable monuments are being destroyed. Cleopatra's Needle has been behind the Metropolitan Museum since 1880, and it has deteriorated more since then than it did during the 3,000 years it spent in the deserts of Egypt.

All of the above effects have an economic cost. Recently estimates put economic damage in the United States at the following levels per year:

| | |
|---|---|
| Human health costs | $20.1 billion |
| Residential property costs | 6.2 billion |
| Other property costs | 5.1 billion |
| Crops and livestock cost | 1.0 billion |

This averages out to several hundred dollars per family per year.

The least direct, yet probably most serious effect of air pollution, is its effect on the ability of the Earth to sustain life as we know it. The extent of the damage to the crucial and fragile balance of the biosphere, the life-supporting portion of the Earth, has not yet been estimated, although we know that $CO_2$ from fossil fuel burning is changing Earth's climate.

1. What is meant by the synergistic effects of pollution? Give an example.

2. Give an example of each:

   a. Short-term effect of pollution

   b. Long-term effect of pollution

   c. Possible, but not yet verified, effect of pollution

## LABORATORY WORKSHEET 3.20 (continued)

3. Give an example of each:

   a. Air pollution effect on health

   ______________________________________________

   b. Air pollution effect on the economy

   ______________________________________________

   c. Air pollution effect on materials

   ______________________________________________

4. Why has the effect of air pollution on the biosphere been said to be the most serious threat to our environment?

   ______________________________________________

   ______________________________________________

   ______________________________________________

## Lesson 6: CONTROLLING AIR POLLUTANTS

AIM: "How can we reduce the air pollution that comes from factories and from oil and coal fuels?"

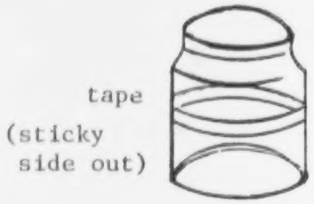
PERFORMANCE OBJECTIVES: The students will be able to:

- explain how precipitators reduce the amount of factory pollutants that enter our air.
- list ten effects of air pollutants on the human body.

MATERIALS: Laboratory Worksheet 3.21, ring stand and clamp, glass chimney about 60 cm tall, two pieces of aluminum foil, transparent tape, incense stick, two pieces of bell wire (25 cm each in length) with alligator clips on each end, electrostatic generator, matches, watch glass.

**NOTE TO TEACHER:** Prior to lesson, have the students set up transparent tape detectors at certain locations. Baby food jars or other small jars are ideal. In windy locations, the jars can be filled with sand or water to hold them in place.

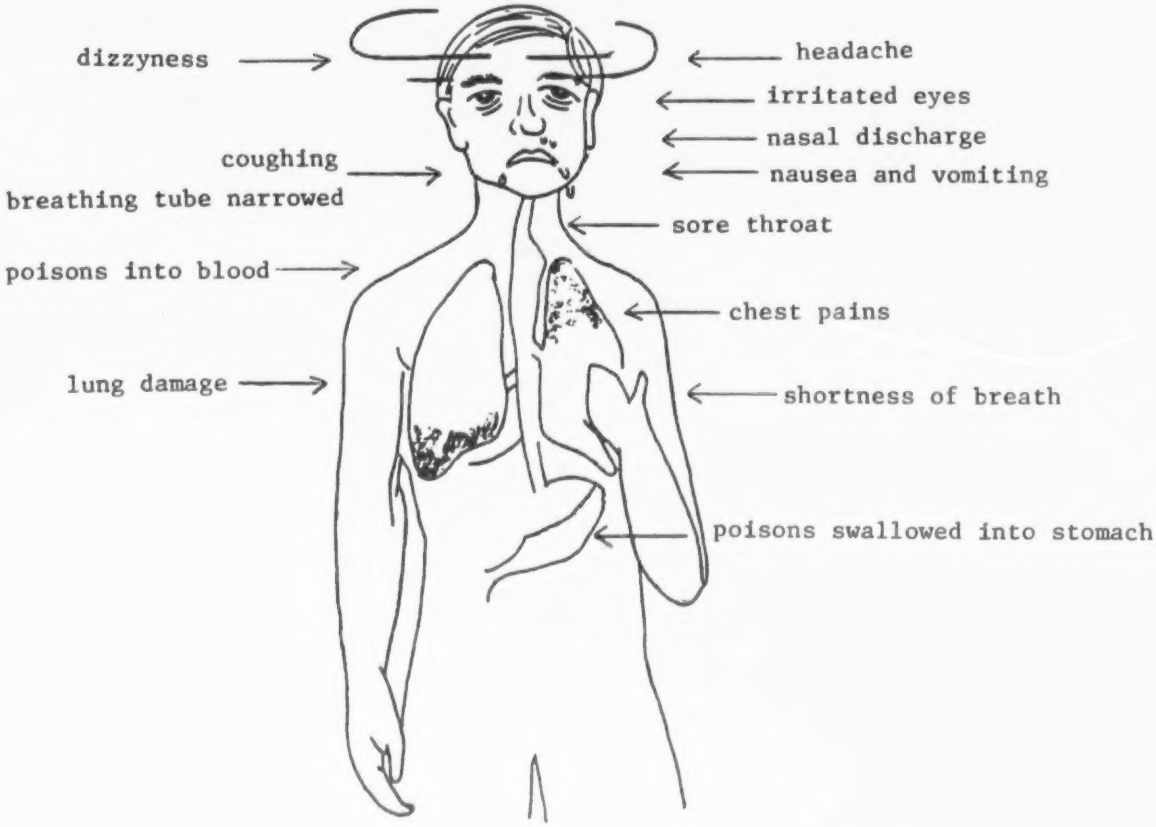
TAPE DETECTOR



After exposing the detector for a fixed period of time (one hour), remove the transparent tape and place it sticky-side-down on a microscope slide. In a similar way prepare a reference set of slides of particles from an auto exhaust pipe, chimney, dust, cigarette ash, etc. Be sure reference slides and all slides are carefully labelled. They will be used in Lesson 9.

**MOTIVATION:** Place the following on overhead transparency or handout sheet:

## DIRTY AIR IS SHORTENING YOUR LIFE


dizzyness
headache
irritated eyes
nasal discharge
coughing
breathing tube narrowed
nausea and vomiting
sore throat
poisons into blood
chest pains
lung damage
shortness of breath
poisons swallowed into stomach

"This year factories will put 14 million tons of carbon gases and 17 million tons of particles as well as 42 million tons of sulfur and nitrogen gases into the air you breathe."

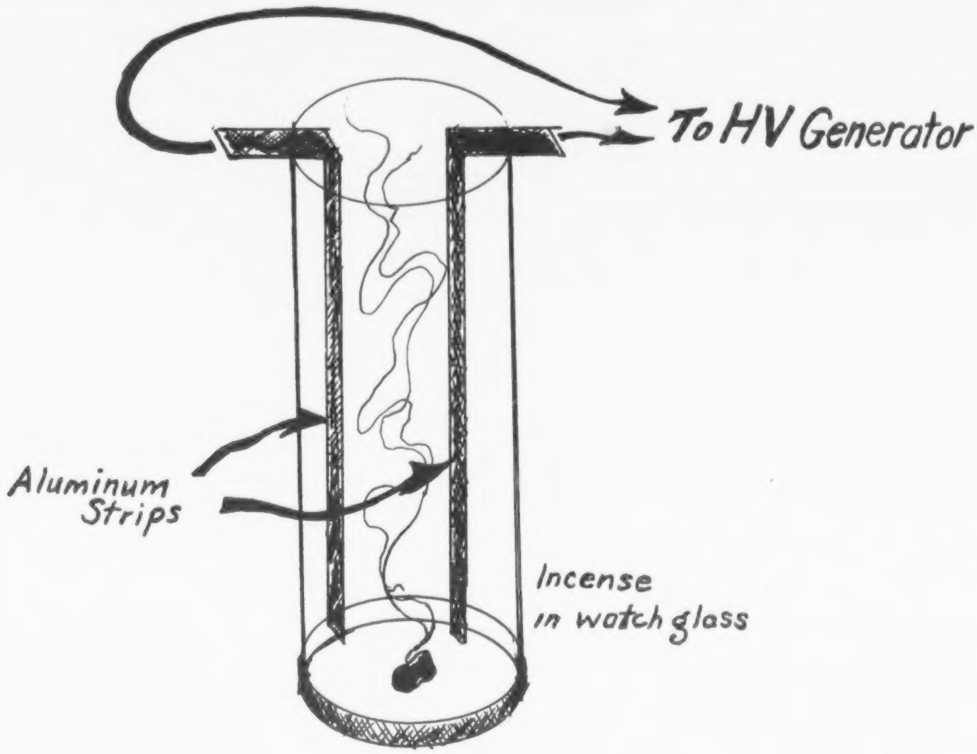
**DEVELOPMENT**

1. Discuss with students the problems of pollutants produced by factories and by the burning of coal and oil in the production of electricity.

2. Have the class discuss disposal of garbage by incineration and an alternative solution, landfills.

3. Demonstrate an electrostatic precipitator to remove particulate matter.

   In this lesson, smoke is passed along a coil of wire that has a positive electrical charge. This, in turn, causes a charge to be built up on the smoke particles. In the center of the coil is a negatively charged rod. The positively charged particles in the smoke are attracted to the rod where they can be collected in bags or containers.



4. Distribute Laboratory Worksheet 3.21 and have class complete the worksheet.

SUMMARY

1. "What should we do with our garbage if burning it will pollute the air and burying it will pollute the soil?"

2. "Name three symptoms caused by breathing polluted air."

RECOMMENDED READING MATERIAL

"Update: New York City's Air Quality; and Overview of the Department's Responsibilities and Functions," available from the City Record Sales Office, 31 Chambers Street, N.Y., 10007.

# LABORATORY WORKSHEET 3.21

NAME____________________________ CLASS____________ DATE____________

1. Who in New York City enforces our laws against air pollution? (Since 1969, the New York City Department of Air Resources has produced a Daily Air Pollution Index. It describes pollution levels in the City during the 24 hours preceding the report [from 3 p.m. the previous day to 3 p.m. the current day]. They describe the air quality as follows:)

   a. Good -- levels for the day were at or below the Federal standard.

   b. Acceptable -- although the Federal standard was not met, the levels are not so high as to jeopardize meeting that standard over the course of a year.

   c. Unsatisfactory -- if these levels were to occur over a substantial number of days, the standard would not be met.

   d. Unhealthy -- refers to chronic, not short-term exposure to levels above the Federal standard.

A Study of the Air Pollution Index for New York City
(data represents the number of days for a given year)

| Pollution Level | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|---|---|
| Good | 0 | 0 | 61 | 58 | 48 | 108 | 107 | 151 |
| Acceptable | 38 | 86 | 198 | 252 | 229 | 193 | 204 | 121 |
| Unsatisfactory | 209 | 196 | 80 | 48 | 65 | 27 | 23 | 49 |
| Unhealthy | 114 | 79 | 26 | 7 | 23 | 36 | 19 | 45 |

2. What changes have occurred in the air quality in New York City over the eight years represented in the chart?

________________________________________

________________________________________

3. What possible reasons are there for these changes?

________________________________________

________________________________________

## LABORATORY WORKSHEET 3.21(continued)

4. What can cause "unsatisfactory" and "unhealthy" conditions in New York City?

5. Until recent years, sulfur dioxide was a major pollutant in New York City. Why has this changed?

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. The automobile is considered to be the most serious polluter of our air. Write a report about how the automobile pollutes the air.
2. Why is city air more "dangerous" than country air?
3. Why were garbage compactors used to replace burning incinerators? What additional problem has the compactor caused?

### ESSENTIAL VOCABULARY

1. pollutant
2. precipitator
3. irritation
4. discharge

# Lesson 7: SMOG

AIM: "When is air pollution most dangerous and harmful?"

PERFORMANCE OBJECTIVES: The students will be able to:

. define smog.
. list the conditions necessary for two kinds of smog.

MATERIALS: Incense, matches, smoke paper or incense stick, sheet of rubber, rubber band, chalk dust, ice, two large beakers (1000 cc, 2500 cc).

MOTIVATION: "In 1953, over 200 New Yorkers died from air pollutants in a few days. How could this happen again?"

DEVELOPMENT

1. Write the words "smoke," "smog," "sun," and "smell" on the board.

2. Demonstrate and discuss smog (smoke and fog). To demonstrate fog, pour about 3 cm of water into a 100 ml beaker. Cover opening with a rubber sheet for 10 minutes, then scrape some chalk dust into the beaker from a chalkboard eraser. Replace rubber sheet and seal securely with rubber bands. Push your fist against the rubber seal until your fist is actually inside the beaker. This will warm up the air and the air will hold more water vapor. After 10-15 seconds remove your fist quickly and a cloud will form. Repeat with smoke added from burning smoke paper or incense.

3. Explain conditions for:

| London Type (smog) | Los Angeles Type (photochemical) |
|---|---|
| a) stagnant air | a) sunny day |
| b) soft coal producing a high content of smoke particles | b) exhaust from cars: nitrogen oxides and hydrocarbons |
| c) temperature below 10° C | c) no wind or temperature inversion |
| d) fog present | |

4. Explain temperature inversion.

Under a high pressure center with calm wind and clear sky, the air near the surface of the Earth is heated and rises. As air on hills or mountain slopes is cooled, it becomes heavier and slides downward to the lowest level it can find. Thus, a layer of warm air may be located over a layer of cool air. This upper layer of warmer air is known as a temperature inversion layer. Warm, smoky air from home furnaces, industry, or automobiles will rise as long as it is warmer than the surrounding air. When it reaches the layer of air above it that is warmer, the polluted air stops rising. Smoke, gases and pollutants form smog and begin to collect under the inversion layer which is acting like a lid on the area. This condition occasionally lasts for many days, creating dangerous health conditions. To break up an inversion of this kind, there is usually a great change in weather: precipitation, strong winds, or the arrival of cooler air.

## SUMMARY

1. "Why is air pollution a problem or concern?"
2. "How is the London-type smog different from the Los Angeles-type smog?"
3. "Why should people who live on farms be as concerned about air pollution as you are?"
4. "Why must a scientist studying air pollution know a good deal about the weather?"

## FOR FURTHER THOUGHT

1. Have class investigate killer smog episodes in the United States.
2. Discuss with students possible solutions to the smog problem.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

Write a report to answer the following questions:

- Can smog be deadly?
- Why is smog common in urban areas?
- What is a radiation fog?

### ESSENTIAL VOCABULARY

1. smog
2. incense
3. fog
4. smoke
5. stagnant
6. photochemical
7. hydrocarbons
8. temperature inversion

## Lesson 8: POLLUTANTS IN AUTOMOBILE EXHAUSTS

AIM: "How can air pollution be reduced?"

PERFORMANCE OBJECTIVES: The students will be able to:

- name and describe four harmful gases found in automobile exhaust.
- describe three ways of reducing air pollution caused by automobiles.

MATERIALS: None.

MOTIVATION: "Unleaded gasoline is more expensive for high performance automobile engines than 'regular' gas. Why are the newer models of automobiles made to use only the unleaded variety?"

DEVELOPMENT

1. List and discuss with the class the gases in automobile exhaust smoke and their effects upon us.
   a. carbon monoxide -- deadly gas -- prevents oxygen from reaching body cells.
   b. hydrocarbons -- cause plants to wither and die.
   c. nitrogen dioxide and hydrocarbons -- may produce photochemical smog in the presence of sunlight. Smog damages the cilia of the respiratory system and makes the heart work harder.
   d. aldehydes -- irritate eyes, nose, and throat membranes.
   e. lead -- lead poisoning -- headaches, anemia (paralysis, blindness, and insanity in higher doses, finally death).
2. Ask: "What can be done to reduce the hazards of auto exhausts?"
   a. catalytic converter -- converts carbon monoxide (CO) hydrocarbons into carbon dioxide and water ($CO_2 + H_2O$). Point out that this will only work with unleaded gasolines.
   b. blow-by tube recycles unburned gases.
   c. air injection system -- burns off some of the excess gases.
3. Ask: "How can power plant pollution be reduced?"
   a. Reduce your consumption of electric power. Turn off lights, radio, and TV when no one is using them. This can be true for all electrical appliances.
   b. Work for adequate pollution control equipment on electric power plants.

4. Waste disposal and burning refuse are responsible for about 5% of the total air pollution. Have students suggest how this type of pollution might be reduced.

    a. Don't burn leaves or trash.

    b. Reuse and recycle whenever you can.

    c. Work for sanitary landfill disposal, or the installation of modern municipal incinerators that can produce heat and electricity instead of pollution.

5. Ask: "What has the government done to insure clean air for all of us?" Explain that the Clean Air Act was passed by Congress for the following purposes:

    a. Air pollution prevention and control through research, technical and financial assistance to state and local governments, to assist in the development and operation of regional air pollution control programs.

    b. Establishment of emission standards for moving sources: motor vehicles, aircraft, etc.

SUMMARY

1. "Do you think that only lead-free gasoline should be sold?"

2. "How is auto exhaust related to photochemical smog?"

FOR FURTHER THOUGHT

1. "How can we reduce the amount of auto pollution in our neighborhoods?"

2. "What has New York City done to ensure that we have cleaner air?"

## OPTIONAL ACTIVITY

### Nationwide Emissions of Air Pollutants

The following table summarizes the estimates nationwide (U.S.A.) of emissions of air pollutants for 1968.

MILLIONS OF TONS

| Source | Carbon Monoxide | Particulates | Sulfur oxides | Hydrocarbons | Nitrogen oxides |
|---|---|---|---|---|---|
| Transportation | 63.8 | 1.2 | 0.8 | 16.6 | 8.1 |
| Fuel combustion in stationary sources | 1.9 | 8.9 | 24.4 | 0.7 | 10.0 |
| Industrial processes | 9.7 | 7.5 | 7.3 | 4.6 | 0.2 |
| Solid waste disposal | 7.8 | 1.1 | 0.1 | 1.6 | 0.6 |
| Miscellaneous | 16.9 | 9.6 | 0.6 | 8.5 | 1.7 |
| Total | 100.1 | 28.3 | 33.2 | 32.0 | 20.6 |

Source: Andrews et al., *Environmental Pollution* (Englewood Cliffs, NJ: Prentice Hall, 1972).

1. a. Calculate the total amount of air pollutants produced in 1968?

   b. Of this total, what percentage was contributed by transportation?

   c. For each of the 5 categories of pollutants, calculate the percentage that is contributed by transportation.

   d. Opponents of expressway construction and of vehicular traffic in downtown areas quote the figure that you determined in b as evidence that the automobile is the main culprit in air pollution. Automobile manufacturers point out that the use of the total percentage figure is not realistic because some pollutants are more harmful than others. What do you think? Why?

2. a. 24.4 million tons of sulfur oxides were produced by the burning of fuels in stationary sources. What percentage of the total is this?

b. Coal combustion accounted for 20.1 million tons of sulfur oxides and fuel oil combustion for another 4.3 million tons. Stated differently, power plants produced 16.8 million tons, industrial plants 5.1 million tons, and space heating of homes and businesses, 2.5 million tons. Suggest steps that could be taken to lessen the amount of sulfur dioxide released into the air. Discuss the feasibility of your suggestions.

3. a. What percentage of the total carbon monoxide emission was produced by transportation vehicles?

   b. Supporters of expressway construction in cities often state that automobiles produce more carbon monoxide when they are driven slowly. Therefore, they argue, carbon monoxide pollution can be reduced by building expressways to keep the traffic moving faster. Research appears to back up their opinions. In the United States, vehicular traffic is almost evenly divided between rural and urban areas. Yet, 70% of the carbon monoxide produced by vehicles is found in urban areas where driving speeds are slower. Do you agree with those who support the construction of more expressways? Why or why not?

4. a. Nitrogen oxide emissions for 1970 totalled 23 million tons. What do you think were the main reasons for the increase over the 1968 value?

   b. There are over 940 power plants in the United States that burn fossil fuels. They produce 16.8 million tons of sulfur oxide and 4.0 million tons of nitrogen oxides, large quantities of dangerous pollutants which would be eliminated if the power plants were replaced by nuclear power plants. Discuss the feasibility and/or desirability of doing so.

5. The following table gives the populations of 5 cities and the number of tons of particulate matter falling on each of the cities per year.

| City | Population (metropolitan area) | Number of tons of particulate matter |
|---|---|---|
| Chicago, Ill. | 7,225,000 | 600,000 |
| Pittsburgh, Pa. | 1,955,000 | 400,000 |
| Philadelphia, Pa. | 4,200,000 | 200,000 |
| Los Angeles, Calif. | 7,635,000 | 177,000 |
| Denver, Colo. | 1,035,000 | 33,000 |

   a. Calculate the amount of particulate matter that settles per year for each person in each of these cities.

   b. Rank these cities with the "dirtiest" city at the top.

   c. Examine carefully the sources of particulates given in the table on the previous page. Account for the ranking in "b" above.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Prepare a pollution bulletin board. Have the class bring in articles about pollution and what is being done to minimize it.
2. Have the class write letters to General Motors, Ford and Chrysler Corporation asking about the advances made in engine design to minimize air pollution.
3. What is carbon monoxide poisoning? Where can it occur?

ESSENTIAL VOCABULARY

1. exhaust
2. combustion
3. catalytic converter
4. unleaded
5. photochemical

## Lesson 9: COMPOSITION OF DUST

AIM: "What solid particles are suspended in our air?"

PERFORMANCE OBJECTIVES: The students will be able to:

- identify particulates in the air.
- compare particulates found in laboratory experiments with samples of known solid pollutants from various common sources.
- assess the relative pollution level of the air.

MATERIALS: Laboratory Worksheet 3.22, slides of air samples, hand lenses, solid air pollutant slides (cigarette ash, car exhaust, dust, chimney exhaust, etc.).

MOTIVATION: "Why is the household chore of dusting never finished?" "What is a 'clean' room?"

DEVELOPMENT

1. Copy the following chart on the chalkboard:

| Location | Time of Day | Particles | Weather Condition |
|---|---|---|---|
| | | | |

Air pollutants can be solid particles, liquid droplets, or gas. Both solid and liquid air pollutants are known as particulates. This type of pollution can be seen when a ray of light shines through a window. Most of the particulates are very tiny -- from 1/100,000 to 1/2 the size of the period at the end of this sentence. Tons of these particles fall over New York City every day. There are several types of particulates:

a. Dust is composed of irregularly shaped, almost microscopic particles. Most of the dust in the atmosphere comes from volcanoes and meteors that have burned in the Earth's atmosphere. Inside buildings, most of the dust is in the form of fibers that come from rugs, draperies, furniture, or clothing.

b. Soot or fly ash is a byproduct of combustion. An incinerator, furnace, or poorly tuned automobile engine produces large quantities of soot or fly ash. These particles are round and smooth and are composed of carbon.

c. Pollen is produced by flowers in the spring and fall of the year for reproduction. A pollen grain is usually symmetrical, but there are many different shapes.

d. Friction particles are composed of many substances. Rubber particles are produced from tires as they spin along the road. Metal particles are formed from the nickel and steel inside automobile engines; lead particles are from gasoline.

e. Aerosols are particles of solids or liquids that are small enough to remain suspended in the atmosphere. Spray cans of paint, deodorant, and cleaning solutions contribute many of these aerosol pollutants.

2. Guide students through Laboratory Worksheet 3.22.

## FOR FURTHER THOUGHT

- "How is plant growth affected by accumulated dust fall and by specific components of dust fall?"

# LABORATORY WORKSHEET 3.22

NAME________________________ CLASS______________ DATE______________

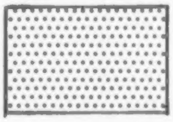
**PROBLEM:** What solid pollutants can we find in our air?

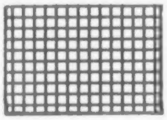
**INTRODUCTION:** Your task today will be to identify the pollutants that are on the air pollution detection tapes that you exposed in Lesson 6. Your information will be pooled along with that of your classmates. The data may reveal that your neighborhood has an air pollution problem and might lead you to the source of it.

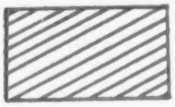
**MATERIALS:** Slides of air samples, hand lenses, solid air pollutant slides, (cigarette ash, car exhaust, dust, chimney exhaust, etc.).

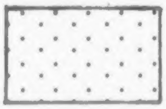
**PROCEDURE**

1. Examine the "known" slides that are on the demonstration table.









2. Draw what is on your tape:

Date ______________________

Time began ________________

Time ended ________________

Sample taken at ____________

# LABORATORY WORKSHEET 3.22(continued)

3. My pollution tape showed the presence of ______________________

______________________ and ______________________

4. What types of particles were present in the largest amount?

______________________ and ______________________

5. This chart is to be completed by all groups reporting:

| Location | Time of Day | Particles | Weather Condition |
|---|---|---|---|
| | | | |

SUMMARY/HOMEWORK

1. The dirtiest place was ______________________

2. The particulate matter found most often by the class was

______________________

3. What effect will the weather have on particulate matter? For example:

windy conditions: ______________________

rainy conditions: ______________________

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. How does the weather affect air pollution? What effect does air pollution have on the weather?
2. What have we done in New York City to cut down on chimney exhaust?
3. Why do people who live in urban areas have to dust their furniture more often than those in rural areas?

### ESSENTIAL VOCABULARY

1. detection
2. exposed
3. urban
4. rural

# Lesson 10: REMOVING POLLUTANTS FROM THE AIR

AIM: "How are pollutants removed from the air?"

PERFORMANCE OBJECTIVES: The students will be able to:

. recognize the odor of the sulfur dioxide gas that causes acid rain.
. demonstrate a technique for scrubbing polluted air.
. demonstrate a technique for removing particulate pollutants from the air.

MATERIALS: 4 gas collecting jars, 3 sections of rubber hose, 4 lengths of straight glass tubing, 4 pieces of bent glass tubing, 3 two-hole rubber stoppers, 5 ml of dilute hydrochloric acid, 3 g of solid sodium bisulfite, thistle tube, blue litmus paper (see diagram), 2 glass chimneys, cotton, concentrated hydrochloric acid, ammonium hydroxide, aluminum foil, Tesla coil.

MOTIVATION: "Gases that pollute the air can be removed at the source by a process called scrubbing. Why is it important to scrub factory exhausts?"

DEVELOPMENT

* **NOTE TO TEACHER:** $SO_2$ gas can be very irritating. Use care and adequate ventilation.

1. Demonstrate a scrubber model as follows:

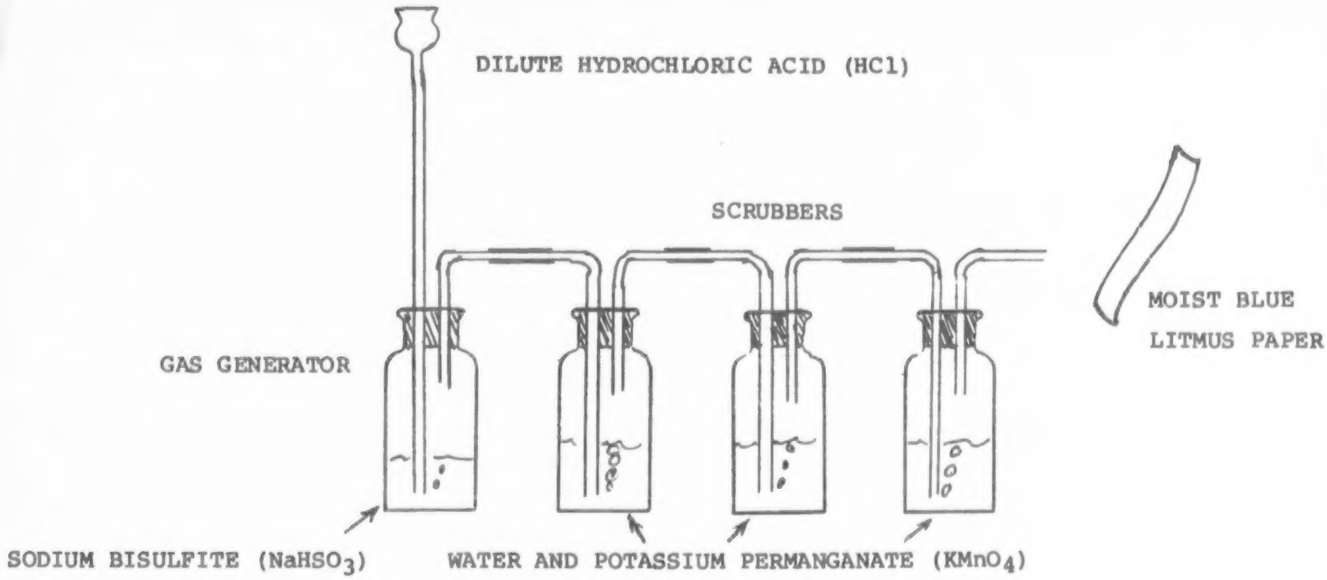
   a. Make a gas generator by adding 3 grams (one-half teaspoon) of sodium bisulfite in a gas collecting jar and inserting a long thistle tube and a piece of bent glass tubing through a two-hole stopper in the neck of the jar.

   b. Pour dilute hydrochloric acid into the thistle tube until the jar is about half full. Have the class observe the bubbles of sulfur dioxide that form in the jar. Ask a student to sniff the gas cautiously and describe the odor to the class. (It smells something like burnt matches.)

   c. Have a student test the gas with a piece of moist blue litmus paper and observe the color change that occurs as the gas makes contact with the paper. (It should turn red.)

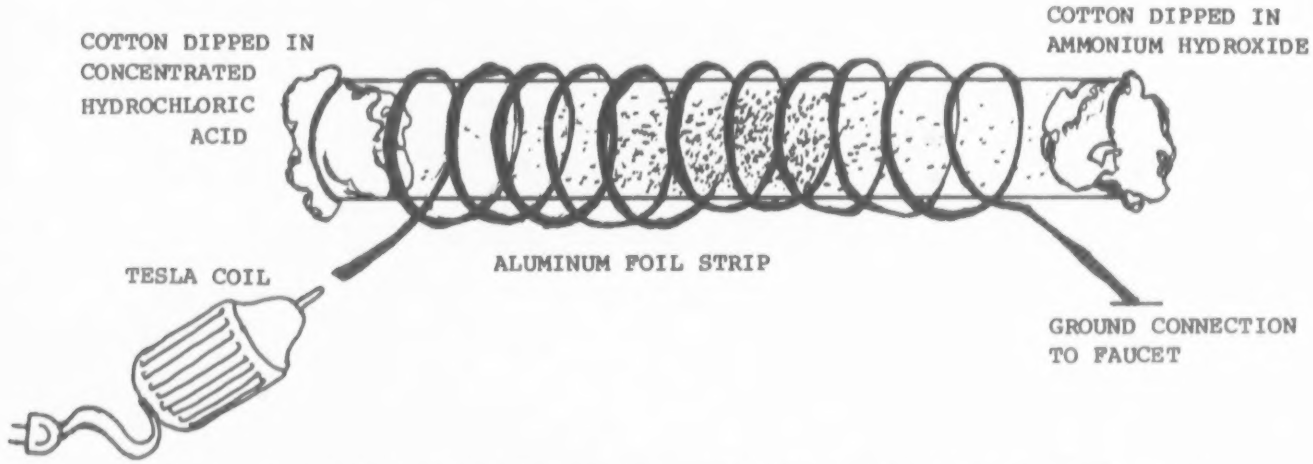
   d. Prepare three gas-collecting bottles to act as a scrubber by inserting glass tubing through two-hole stoppers and connecting the sections with lengths of rubber hose as shown in the diagram. Fill each of these jars halfway with violet potassium permanganate solution.

   e. Connect the scrubber to the gas generator and ask the class to look for a color change in the potassium permanganate solutions. The solution in the first jar of the scrubber will change color from violet to colorless in a very short time but there will be a time delay before the solutions in each of the other two jars respond to the gas. Elicit the reason for this delay. It is caused by the fact that sulfur dioxide gas is very soluble in water and it is retained by the first jar of the scrubber until the liquid is saturated.


DILUTE HYDROCHLORIC ACID (HCl)
SCRUBBERS
MOIST BLUE LITMUS PAPER
GAS GENERATOR
SODIUM BISULFITE ($NaHSO_3$)
WATER AND POTASSIUM PERMANGANATE ($KMnO_4$)

f. Have a student hold a piece of moist blue litmus paper at the scrubber output end. Becuase of the "scrubbing action" of the liquid in the three jars the class should observe that there is no change in the color of the litmus paper until the scrubbing solutions have become saturated.

2. Demonstrate an electrostatic precipitator as follows:


COTTON DIPPED IN CONCENTRATED HYDROCHLORIC ACID
COTTON DIPPED IN AMMONIUM HYDROXIDE
TESLA COIL
ALUMINUM FOIL STRIP
GROUND CONNECTION TO FAUCET

a. Generate particulate pollutants in air by stuffing the ends of a glass chimney with cotton dipped in hydrochloric acid and ammonium hydroxide respectively. When the two react at the center of the chimney, a dense ammonium chloride smoke will be produced.

b. Wind a thin strip of aluminum foil around the outside of the chimney and ground one end by connecting it to a faucet or other ground connection. Apply an electrostatic charge to the foil by touching the opposite end with a Tesla coil or an electrode of a Wimshurst generator. Have the class observe that the smoke clears immediately and the particles are deposited on the inner surface of the glass chimney.

3. Ask: "How can we reduce air pollution by improving our waste disposal?"

    a. Don't produce smoke by burning any leaves or trash.
    b. Buy food in reusable containers which do not require any incineration.
    c. Reuse and recycle, whenever possible.
    d. Work for construction of a sanitary landfill disposal or the installation of modern municipal incinerators that can produce heat and electricity instead of air pollution.

4. Ask: "What have government agencies done to ensure clean air for all of us?" Explain that the Clean Air Act was passed by Congress for the following purposes:

    a. Air pollution prevention and control through research, technical and financial assistance to state and local governments.

    b. Assistance in the development and operation of regional air pollution programs.

    c. Establishment of emission standards for the following moving sources: motor vehicles, aircraft, etc.

5. Distribute copies and have the class read the article "Control of Air Pollution." Then have them write a paragraph on how the government has tried to clean up the air.

## SUMMARY

1. "What are two techniques for reducing air pollution?"

2. "How can you help eliminate air pollution?"

## FOR FURTHER THOUGHT

1. Discuss the role of the Environmental Protection Agency in reducing air pollution.

2. Investigate the use of solid waste as a fuel to produce electrical power.

3. Find out how Cottrell precipitators are used to remove particles from industrial smoke stacks.

4. Visit a local service station that inspects automobiles for pollutants from the exhaust. Describe how the tests are performed and the requirements that must be met to pass each test.

## Control of Air Pollution

Action taken to restore air quality varies from none in many instances to a complete ban on the sale of internal combustion engines (as proposed in 1969 by the California State Assembly but not adopted). In between these extremes, state and federal agencies are enforcing various types of control that reduce, at least partially, the incidence of one pollutant or another.

"Smokeless" fuel zones in cities reduce the amount of particulate matter and often lesson the amount of sulfur dioxide released. The establishment of such a zone in London following a 1952 disaster is reported to have prevented any recurrence of its infamous "pea-souper" fogs. In most large cities there are generally regulations concerning domestic and industrial burning of garbage. Natural gas and diesel oil are in any case the most common forms of fuel now used in the United States.

Since 1968 all new cars sold in this country had to be fitted with some kind of exhaust emission control device. The first device was concerned with crankcase hydrocarbon emissions; the PVC valve, as this type of device was called, was intended to reduce crankcase emission 100 percent.

Further regulations for control of vehicular emissions were implemented in 1971 and again in 1975. The devices on the 1971 models controlled evaporative emissions of hydrocarbons from the carburator and gas tank. The 1975 standards were set to control particulate emissions. As it seemed impossible within the time available to produce a device handling lead particulates, it was prescribed that these 1975 models be operated on lead-free gasoline. It is estimated that these requirements could reduce emissions of hydrocarbons, carbon monoxide, and oxides of nitrogen in California to a minimum by about 1985. Moreover, these figures might prove to be lower than at present, due to a reduction of emmisions in 1971 and later automobile models of carbon monoxide to 33 1/3 percent and hydrocarbons to 23 percent. This even allows for an appropriate increase in the number of motor vehicles.

Starting with 1975 models, all new cars sold in California must be fitted with a catalytic converter and operated with lead-free gasoline. Additionally all

1966-1970 used cars registered in the counties sharing the Los Angeles air shed must, before mid-1975, be fitted with an additional smog control device. This device will reduce nitrogen oxide emissions, which were not affected by the control devices fitted to new models until 1971. However, taking into account the imperfect function of many control devices and the increases in the atmospheric load of pollutants from world-wide sources, it is not certain that the automotive controls just described will result in a significant reduction of urban smog in Los Angeles or in the country as a whole. The chances of some reduction occurring have increased with recent trends toward the use of smaller cars, lower driving speeds, better mileage performances, and increased availability of bus and other rapid transit systems.

A detailed study of the literature, or a period of residence in one of the more heavily polluted cities, may persuade many people that the need for air pollution control is far more urgent than this and that to wait patiently for some reduction to reach its maximum effect in 1985 is not nearly good enough. Unfortunately, conclusions from scientific experiments or analyses of the effects of pollution are not proved; and where so many vested interests are vitally affected, it is difficult to introduce and enforce legislation on the basis of a probable reduction in air pollution.

## ENVIRONMENTAL CONTROL AGENCIES

Environmental concern reached a climax in the United States in 1970, with vigorous representations made by students, scientists, and other citizens, governmental and industrial groups, and the press, all with a common interest in halting further environmental degradation. The response at the federal level was to create the Council on Environmental Quality, which recommended the amalgamation of various scattered federal environmental responsibilities into a single body, the Environmental Protection Agency.

The Environmental Protection Agency, better known by its acronym EPA, was established in 1971 and charged with the formulation and enforcement of laws for the protection of the environment. One of its first responsibilities was implementation of the Clean Air Act of 1970, which called for control of emission sources, and especially stringent curtailment of automobile emissions. By employing an 1899 Refuse Act which had lately been little used, the EPA was also able to move vigorously to discourage pollution on navigable waterways.

During the early seventies, numerous countries established agencies similar to the EPA. Moreover the increasing gravity of global environmental problems promoted the organization in 1972 of the United Nations Conference on the Human Environment in Stockholm, Sweden. The Stockholm Conference produced three major concepts: a declaration of broad environmental principles, an environmental management plan, and a global environmental agency. The last, known as the Governing Council for Environmental Programs, has been located in Nairobi, Kenya. It remains at this time in its establishment phase; little progress has been made as yet in the implementation of the international plan of action for environmental management agreed upon in Stockholm.

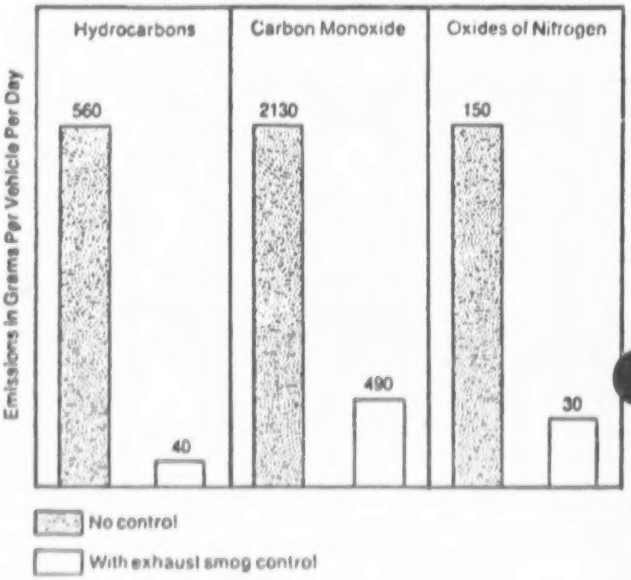


**FIGURE A:** Comparison of exhaust emissions from uncontrolled and controlled sources. Amounts represent grams per vehicle per day. The three graphs are on a different scale to reduce them to comparable size. The emission controls are those imposed by recent California emissions standards; the three primary pollutants in smog represented here are very considerably reduced, and the secondary pollutants will likewise by affected.

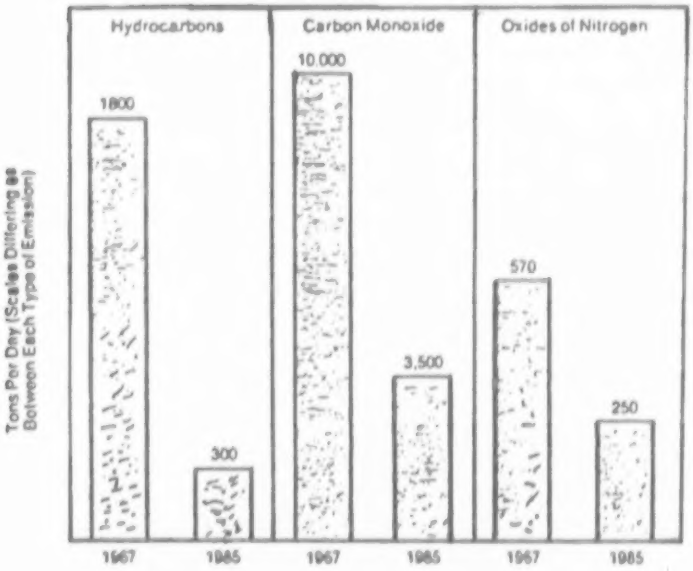


**FIGURE B:** The estimated effects of control regulations on vehicular emissions. These are estimated figures over the 1967-85 period for vehicles registered in the Los Angeles metropolitan area, together with the extent of control established and the amount of estimated emissions.

Arthur Boughey, *Man and the Environment*, 2nd edition, (New York: Macmillan), pp. 400-402.

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Write a letter to the Environmental Protection Agency asking for pamphlets about air pollution and its regulation.
2. What can we do individually to minimize the pollution of our atmosphere?
3. How has "progress" in industry caused problems for man?

### ESSENTIAL VOCABULARY

1. scrubber
2. disposal
3. recycle
4. critical
5. restore
6. implemented
7. regulations

# Lesson 11: CAREERS IN ENVIRONMENTAL SCIENCE

AIM: "What kinds of careers are related to the environment?"

PERFORMANCE OBJECTIVES: The students will be able to:

. plan for future occupations related to the environment.
. understand the need to train more environmental technicians.

MATERIALS: Articles about recent environmental crises; list of occupations in the environmental field.

MOTIVATION: Introduce a current environmental crisis. Ask: "What government agency has the responsibility to solve this crisis?" "What are the jobs of the persons responsible for solving this crisis?"

DEVELOPMENT

1. Ask: "Why are there now many job opportunities in the area of environmental science?" Explain that the field of environmental careers is expanding and that many students can also get involved. There is a need for over 1.5 million workers in the areas of education, research, and technology. Jobs are opening up at the city, state, and federal levels of government, and also in private industry.

2. Ask: "Why are so many jobs becoming available?" Discuss the implications of federal environmental laws.

3. Ask: "What types of jobs are available in the environmental field?"

    a. Environmental equipment operation:

       wildlife attendant, incinerator plant attendant, waste-water treatment plant worker, sanitary equipment operator, solid waste systems manager, zoo keeper, water supply, sanitation

    b. Environmental technology and education

       inspectors, nuclear technicians, mechanical testers, educators, environmental engineers, environmental health services, environmental planners, natural resource managers, sanitation toxicologists, urban planners, soil conservationists

    c. Environmental Science and Research

       entomologists, agronomists, epidemiologists, oceanographers, environmental law specialists

* **NOTE TO TEACHER:** Teachers can obtain copies of Career Choices, produced by the E.P.A. in January 1977, and other more recent information.

## SUMMARY

1. "Why is there a growing need for more environmental technicians?"

2. "Who are some of the specialists who monitor the various kinds of pollution in our city?"

3. "What sort of jobs exist to maintain our 'quality of life'?"

## FOR FURTHER THOUGHT

- "Go to the library to find out what job qualifications are necessary to begin a career in a field in environmental protection that appeals to you."

## Partial List of Occupations in the Environmental Field

| Job | Job Description | Education Required |
|---|---|---|
| Environmental Engineer<br>(very good opportunities) | Management and best use of air, water, land resources | 4 years Engineering + M.A. or Ph.D. in a specialty to advance. Must be in top of H.S. graduating class + 4 years experience + oral and written exams. |
| Environmental Health Technician<br>(opportunities in cities) | Conduct tests, recommend improvements to camps, resorts, schools, communities | No set requirements. At least 2 years junior college, plus field training. |
| Industrial Hygienist | Recognize hazards, prescribe methods to control/prevent hazards in the industrial workplace | College degree--a major in engineering, strong H.S. background in math and science. |
| Sanitarian<br>(Environmentalist)<br>(opportunities greatest in cities) | Interpret and enforce city, state, federal laws regarding sanitary standards; perform tests, inspections | Certification (optional B.A.) in environmental health or basic science. Licensing in 35 states. |

## Lesson 12: PROTECTING OUR LOCAL ENVIRONMENT

AIM: "Who is responsible for protecting our environment in New York City?"

PERFORMANCE OBJECTIVES: The students will be able to:

. identify several occupations in the field of environmental protection.
. describe the job done by the person in each occupation.

MATERIALS: Copies of newspaper articles, opaque projector.

MOTIVATION: Refer to recent newspaper stories about a water crisis, dioxin in water supplies, contamination of Long Island homes by insecticides, or any current envronmental problem. Discuss roles of individuals who are responsible for dealing with environmental problems. List the various occupations on the chalkboard.

DEVELOPMENT

1. Show pictures of smoking chimneys from houses and factories, burning garbage and leaves, exhaust pipes of vehicles, people smoking on a bus, garbage scows on the river, oil tankers spilling oil, trucks carrying hazardous chemicals, radioactive wastes, a nuclear power plant heating the river and threatening the entire region with a potential accident. Ask: "How many different kinds of jobs can you think of which attempt to keep this pollution under control."
2. As jobs are suggested, write them on the chalkboard along with their official titles. Refer to initial list in Motivation.
3. Ask: "What government agencies oversee environmental problems?" "What jobs would they have people doing?"
4. Project another picture showing a city without any trees, parks, or playgrounds. Ask: "What is missing from this scene?"
5. Ask: "What sort of jobs exist to preserve and maintain our quality of life?"

SUMMARY

1. "Who are some of the specialists that monitor the various types of pollution in the city?"
2. "What types of people do these jobs?" "Who works behind the scenes?"

FOR FURTHER THOUGHT

. Suggest students locate and interview one of the following people and prepare a detailed report on job responsibilities and difficulties.

Environmental engineer
Environmental health technician
Industrial hygienist
Sanitarian

# Lesson 13: THE ENVIRONMENTAL PROTECTION AGENCY

AIM: "What role does the government play in improving the environment?"

PERFORMANCE OBJECTIVES: The students will be able to:

- describe the structure of the federal, state and city agencies that handle environmental problems.
- recite the major provisions of at least two of our present environmental protection laws.

MATERIALS: Articles and pamphlets on environmental laws.

MOTIVATION: Headlines or newspaper article dealing with environmental agencies (or an environmental crisis). Discuss the role of a government agency that is charged with handling the problem.

DEVELOPMENT

1. Ask: "What do the initials EPA stand for?" "What is the function of the Environmental Protection Agency?"

   The EPA is charged by Congress to protect the nation's land, air, and water systems. Under a mandate of national environmental laws focused on air and water quality, solid waste management and the control of toxic substances, pesticides, noise, and radiation, the Agency formulates and implements actions which are to lead to a compatible balance between human activities and the ability of natural systems to support and nurture life.

2. Ask: "What is meant by clean air standards?" "Who sets these standards?" "Why are clean air standards important?"

   Guide students through the accompanying handout, "Government Involvement in Protecting the Environment." Explain that various levels of government, from federal to local, share the responsibility of setting and implementing environmental standards.

3. Ask: "How are clean air standards determined?" (Discuss the use of studies with plants and animals in determining harmful levels of pollutant.)

4. Ask: "Once it is found that a certain level of pollution is dangerous, what can be done to keep environmental pollution below that level?"

5. Guide students through a summary of major laws administered by the EPA, using the following information:

Major laws administered by EPA include:

- Clean Water Act, as amended, is the basic authority for water pollution control programs. The goal of the Act is to make national waters fishable and swimmable.
- Safe Drinking Water Act, as amended in 1977, permits EPA to regulate the quality of water in public drinking water systems and the disposal of wastes into injection wells.
- The Resource Conservation and Recovery Act of 1976 ("RCRA") authorizes EPA to establish regulations and programs to ensure safe waste treatment and disposal.
- Federal Insecticide, Fungicide and Rodenticide Act ("FIFRA"), as amended, directs EPA to regulate the manufacture, distribution, and use of pesticides and conduct research into their health and environmental effects.
- Toxic Substances Control Act of 1976 ("TSCA"), provides authority to regulate the manufacture, distribution and use of chemical substances.
- Clean Air Act, as amended in 1977, provides the basic legal authority for the nation's air pollution control programs, and is designed to enhance the quality of air resources.
- Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("Superfund") establishes a program to deal with release of hazardous substances in spills and from inactive and abandoned disposal sites.
- Marine Protection, Research, and Sanctuaries Act of 1972 permits EPA to protect the oceans from the indiscriminate dumping of waste.

## SUMMARY

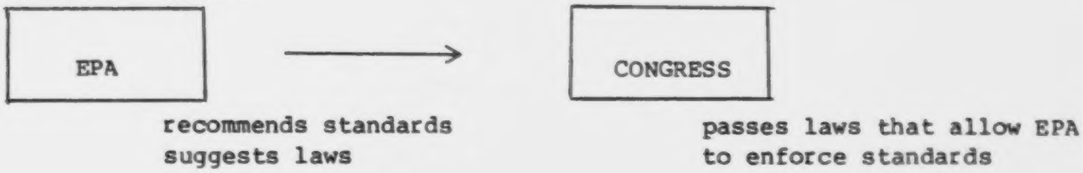
1. "Why is it necessary to have laws passed on the national, state, and local levels?"
2. "Why are we concerned about protecting our environment?"
3. "Why is it important to coordinate and integrate environmental programs?"

## FOR FURTHER THOUGHT

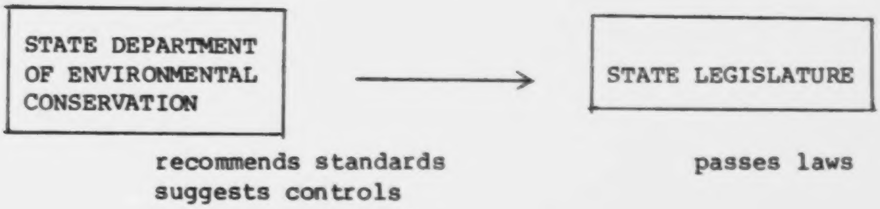
- "Select a current environmental problem and research what national, state, and local governments are doing about it."

## Government Involvement in Protecting the Environment

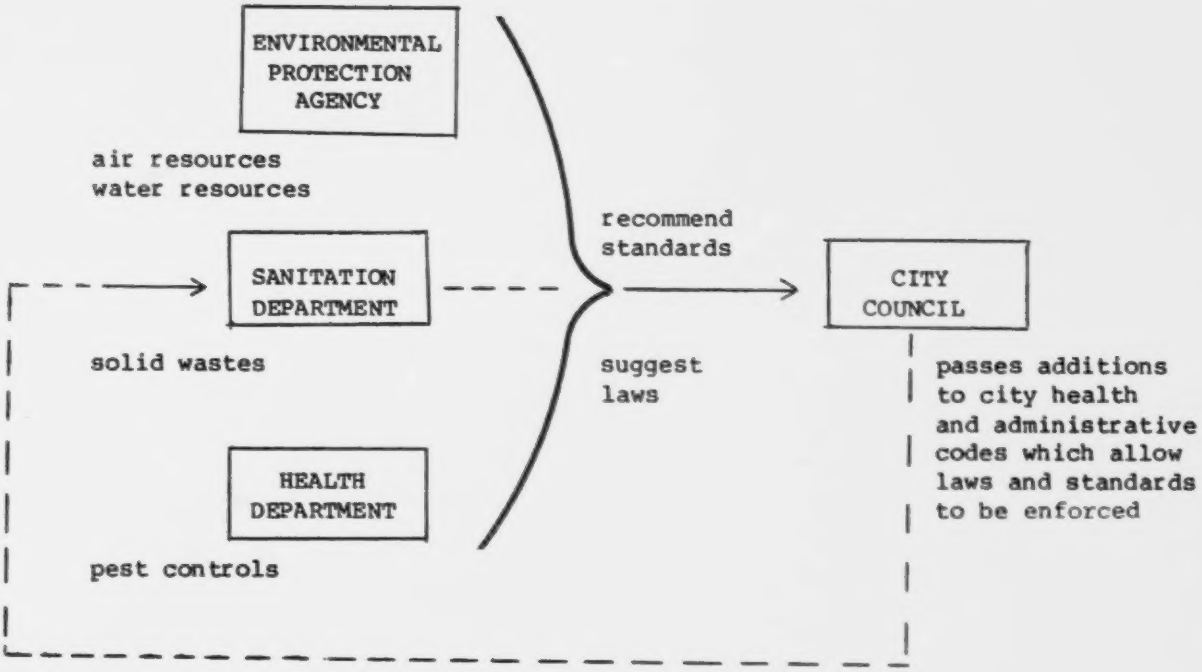
FEDERAL GOVERNMENT


EPA
recommends standards
suggests laws
CONGRESS
passes laws that allow EPA
to enforce standards

NEW YORK STATE GOVERNMENT


STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
recommends standards
suggests controls
STATE LEGISLATURE
passes laws

NEW YORK CITY GOVERNMENT (see job of Environmental Protection Agency)


ENVIRONMENTAL PROTECTION AGENCY
air resources
water resources
SANITATION DEPARTMENT
solid wastes
HEALTH DEPARTMENT
pest controls
recommend standards
suggest laws
CITY COUNCIL
passes additions to city health and administrative codes which allow laws and standards to be enforced

## GOVERNMENT AGENCIES FROM WHICH FREE INFORMATION MAY BE OBTAINED

### New York City Agencies

Bureau of Water Register
Municipal Building
New York, NY 10007
(212) 966-7500

Bureau of Water Supply
1250 Broadway
New York, NY 10001

Bureau of Water Pollution Control
20 Worth Street
New York, NY 10013

Department of Environmental Protection
2358 Municipal Building
New York, NY 10007
(212) 566-4124
Citizens' Complaints (966-7500)

Environmental Control Board
333 W. 34th Street
New York, NY 10001
(212) 971-3600

Bureau of Sewers
40 Worth Street
New York, NY 10013

### New York State Agencies

New York State Energy Research and Development Authority
Agency Building 2
Rockefeller Plaza
Albany, NY 12223
(518) 465-6251

Department of Environmental Conservation
2 World Trade Center
New York, NY 10047
(212) 488-2788

### Federal Agencies

Environmental Protection Agency
401 M Street S.W.
Washington, D.C. 20460
(202) 755-2670

NY Area
26 Federal Plaza
New York, NY 10278
(212) 264-2525

## Lesson 14: RESPONSIBILITIES OF THE INDIVIDUAL

AIM: "What role does the individual have in improving the environment?"

PERFORMANCE OBJECTIVES: The students will be able to:

- familiarize themselves with environmental action groups on the national, state, and local levels.
- accept their responsibility in helping to formulate sound environmental policy.

MATERIALS: Pamphlets and posters from environmental action groups.

MOTIVATION: "In 1983, several Long Island families had to move out of their houses because of problems caused by pest control treatment. What are some of the problems that they experienced?"

DEVELOPMENT

1. Ask: "If you had just heard that a large chemical corporation was planning to build a factory near your home, what concerns might you have?" List on the chalkboard.

2. Ask: "What are some reasons individuals might decide to join together in an environmental group?"

   (Examples: "I Love a Clean New York Committee" works with the Department of Sanitation on anti-littering campaigns. "Citizens Committee for New York" helps individuals and community groups develop and fund projects that will help the city during a fiscal crisis.)

3. Ask: "How can you get involved in seeing that environmental protection programs are carried out?"

4. Discuss the following suggestions taken from a government publication:

How You Can Get Involved

- Write your EPA regional office and ask for more information.
- Find out which agency in your State government is responsible for negotiating an Agreement, and write them for more information.
- Ask specifically for (a) a schedule of the steps for developing the Agreement, including those appropriate for public participation, (b) the names of the persons responsible for negotiating the Agreement and coordinating

public involvement, (c) the placement of your name on the mailing list for all further information about the Agreement.

- Review the information you receive and request more if needed.
- Make your views known to the persons negotiating the Agreement as early as possible.
- Plan to attend any public hearings or meetings and to state your comments briefly. Bring written comments and ask that they be put into the record. Mail your comments in if you are unable to attend.
- Study the "Responsiveness Summary" (which must be submitted with the final draft agreement to the Regional Administrator) to see how your comments have been addressed.
- Get a copy or summary of the final Agreement to see what the State and EPA expect to accomplish in the coming year and what longer range goals have been established. Monitor activities.
- If you get involved too late, - prepare for next year.

5. Begin a list on the chalkboard including the following groups:

Groups in New York City that Can Be Contacted

Dirty lots
Council of the Environment
51 Chambers Street
New York, NY 10007

Littered streets
Civilian Sanitation Patrol
125 Worth Street
New York, NY 10007

Broken up playground or park
Adopt-a-Park Program
345 Park Avenue
New York, NY 10017

Other volunteer Programs
Mayor's Volunteers Corporation
51 Chambers Street
New York, NY 10007

## RECOMMENDED READING MATERIAL

"Noise -- It Hurts!" available from United States Environmental Protection Agency, 26 Federal Plaza, New York, NY 10007.

# THEME IV

# HEALTH AND DISEASE

## Health Education and Science Education

Health education and science education should be complementary subject areas. In science education, there is the opportunity to provide students with a cognitive capability for making informed decisions in health-related practices. In health education, this cognitive base is both reinforced and utilized in providing an instructional plan designed to favorably influence health values, attitudes, and practices that are conducive to the optimum development of the student, the family, and the community.

Teachers and supervisors of health and science education are encouraged to foster this interdisciplinary approach through improved communication and collaboration on a school and district level.

# UNIT 1. INTRODUCTION TO HEALTH AND DISEASE

# Lesson 1: WHAT ARE SOME ILLNESSES THAT CAN LEAD TO DEATH?

PERFORMANCE OBJECTIVES: The students will be able to:

- list different causes of illness and death.
- categorize and differentiate between infectious and noninfectious diseases and/or causes of death.
- distinguish between the symptoms of a disease and the disease itself.

MATERIALS: None.

MOTIVATION: "Of all the diseases in the world, for which five would you most like to find a cure?"

DEVELOPMENT

1. Ask: "What do we mean by the term 'disease'?"
2. Have students each list five diseases in their notebooks.
3. Record the students' lists of diseases on the following type of chart on the chalkboard. The columns should be organized so that you may later head them as follows:

| Diseases | |
|---|---|
| Infectious | Noninfectious |
| | |

* **NOTE TO TEACHER:** Students may give answers that sometimes do not fit easily into the categories of infectious or noninfectious. It might be wise to have a third column to include such things as starvation, diarrhea, drug overdose, alcoholism, loss of blood, etc.

4. Ask: "Why is heart disease listed with diseases such as diabetes and cancer rather than with pneumonia and tuberculosis?"

5. Ask: "What is an infectious disease?" (An infectious disease is one caused by other living things. Many infectious diseases are also contagious, which means they can be passed from one organism to another.)

6. Ask: "What is a noninfectious disease?" (A noninfectious disease is a disease not caused by a living organism.)

   These diseases may be caused by one of the following:
   - dietary diseases
   - gland defects
   - damaged organs
   - diseases of unknown causes

## SUMMARY

1. "What might a doctor try first to learn about a newly discovered disease (such as Legionnaire's disease, AIDS) or any disease in the current news?"

2. "Why would this information be important?"

3. "Why is it important for students in a medical school to study the symptoms of different diseases?"

# Lesson 2: HOW HAS LIFE EXPECTANCY CHANGED FROM 1900 TO TODAY?

PERFORMANCE OBJECTIVES: The students will be able to:

- utilize a data table to construct a line graph.
- draw conclusions based upon a line graph.
- define life expectancy.

MATERIALS: Overhead projector, graph transparency, marking pen, colored pens or pencils.

MOTIVATION: "How long do we expect to live?"

DEVELOPMENT

1. Ask: "What is life expectancy?" (Stress statistical basis.) Have class use different colored pencils to draw lines.
2. Distribute Laboratory Worksheet 4.1. Have students complete the graph portion of their worksheets. (In some classes it may be necessary for the teacher to demonstrate proper graphing techniques.)
3. Use overhead projector to display previously prepared graphs so students can compare these to their own work.
4. Ask: "How can we explain the differences in life expectancies in the last 100 years?"

SUMMARY

- See Laboratory Worksheet 4.1.

FOR FURTHER THOUGHT

- Differentiate between life expectancy and life span.

# LABORATORY WORKSHEET 4.1

NAME________________________ CLASS________________ DATE____________

**PROBLEM:** How has life expectancy changed from 1900 to today?

**MATERIALS:** Colored pencils.

**INTRODUCTION:** One rapidly expanding area in the health field has been the growing number of jobs in nursing homes. An entire new branch of medicine called geriatrics has developed to care for older people. Why do you think this is happening more in recent years than 80 years ago?

**PROCEDURE**

1. Use the information from the data table to do the following using different colored pencils or pens:
   a. Plot the points on the graph for the total ages of life expectancy for each given year from 1900 to 1980. Then connect these points with a solid line. (______)
   b. Plot the points on the graph for male life expectancy for each year. Then connect these points with a series of dashes. (- - - -)
   c. Plot the points on the graph for female life expectancy for each year. Then connect these points with a series of dots. (.......)
2. Answer the following questions based upon information in the graph. (Use full sentences.)
   a. How have total life expectancies been changing since 1900?

      ______________________________________________

      ______________________________________________

      ______________________________________________

   b. What could you predict happening to the total life expectancy in the next 100 years?

      ______________________________________________

      ______________________________________________

## LABORATORY WORKSHEET 4.1 (continued)

NAME____________________

c. Explain what has been happening to the trend in life expectancy since 1950.

d. Compare life expectancy of men to that of women. Hypothesize as to why these differences exist.

SUMMARY/HOMEWORK

. Give reasons for the changes in life expectancies in the past 100 years.

# LABORATORY WORKSHEET 4.1 (continued)

Name ______________________ Class ______________ Date ______________

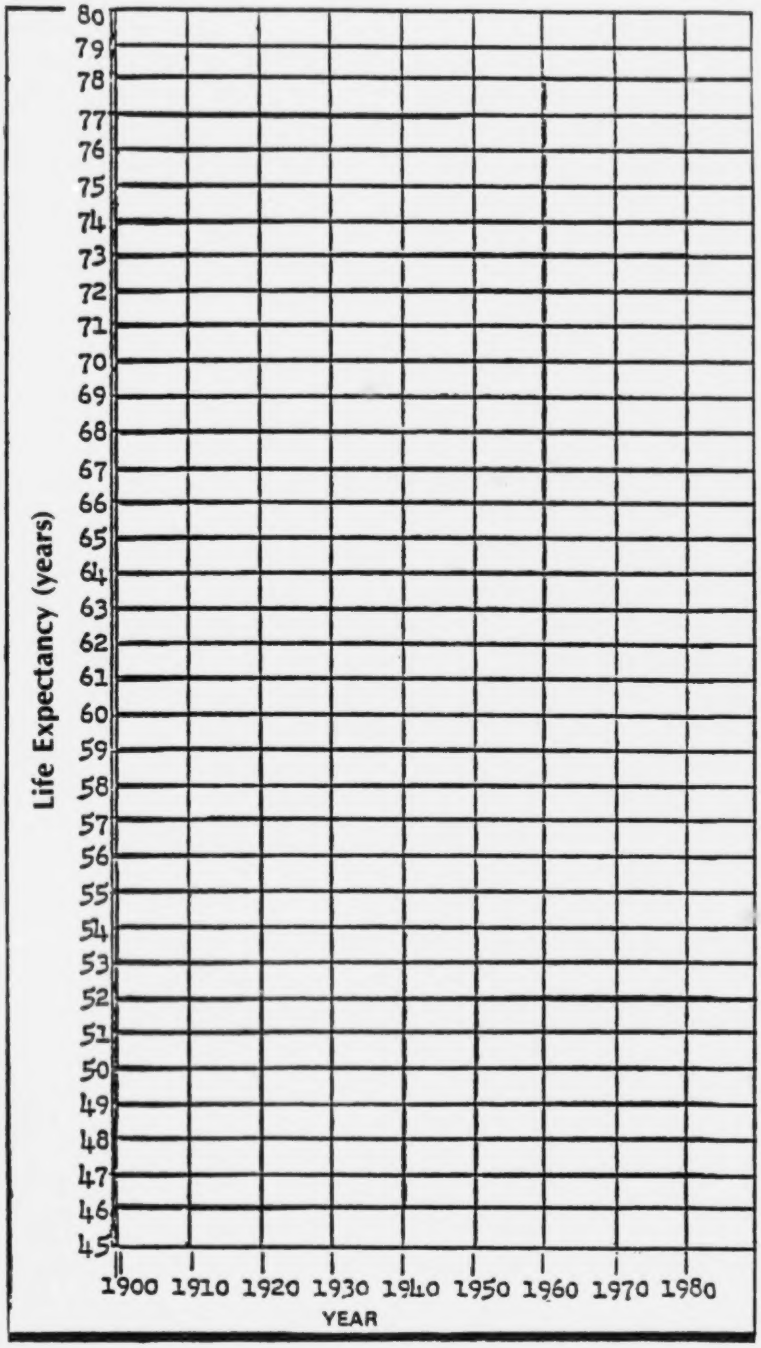
**PROBLEM:**

**What has happened to life expectancy from 1900 to today?**

DATA TABLE *
Life Expectancy (years)

| Year | Total | Male | Female |
|---|---|---|---|
| 1900 | 47 | 46 | 48 |
| 1910 | 50 | 48 | 52 |
| 1920 | 54 | 54 | 55 |
| 1930 | 60 | 58 | 62 |
| 1940 | 63 | 61 | 65 |
| 1950 | 68 | 66 | 71 |
| 1960 | 70 | 67 | 73 |
| 1970 | 71 | 68 | 75 |
| 1980 | 74 | 70 | 78 |

* NOTE: Figures have been rounded off to the nearest whole numbers.



KEY:
———————— Totals
- - - - - - - - - Males
• • • • • • • • • Females

**Follow the directions given in Procedure No. 1**

# Lesson 3: HOW DO THE CAUSES OF DEATH IN THE UNITED STATES TODAY COMPARE TO THOSE IN 1900?

PERFORMANCE OBJECTIVES: The students will be able to:

- use bar graphs to compare and contrast the major causes of death in the United States from 1900 to 1980.
- relate the changes in causes of death to changes in life expectancy between 1900 and 1980.

MATERIALS: Overhead projector, graph transparencies, marking pen, Laboratory Worksheet 4.2.

MOTIVATION: (Refer to the lists of causes of death compiled in Lesson 1.) "What are the major causes of death today?" "What characteristic do they have in common?" (noninfectious)

DEVELOPMENT

- Distribute Laboratory Worksheet 4.2. Have students answer all questions on the worksheet.

FOR FURTHER THOUGHT

1. "How would your graph on life expectancy probably change by the year 2000 if 'breakthroughs' were to be found in the treatment of circulatory diseases and cancer?"

2. "What problems might you foresee for housing, retirement age, social security payments, etc., if there were to be such 'breakthroughs' in the treatment of circulatory diseases and cancer?" "Why?"

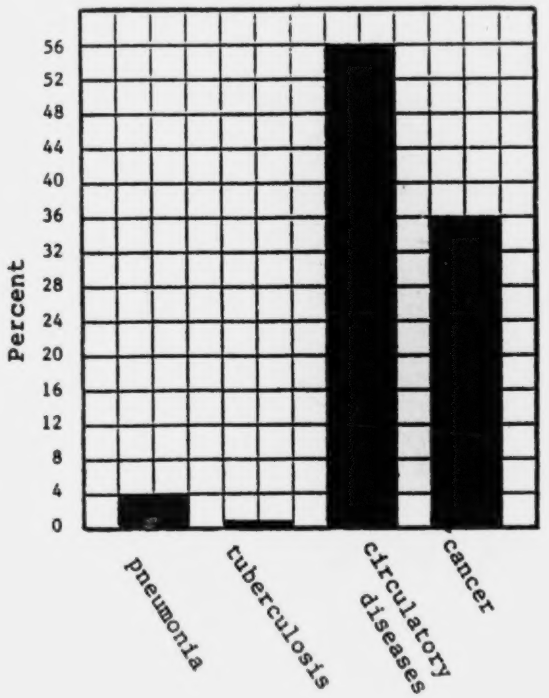
# LABORATORY WORKSHEET 4.2

NAME______________________________ CLASS___________________ DATE_______________

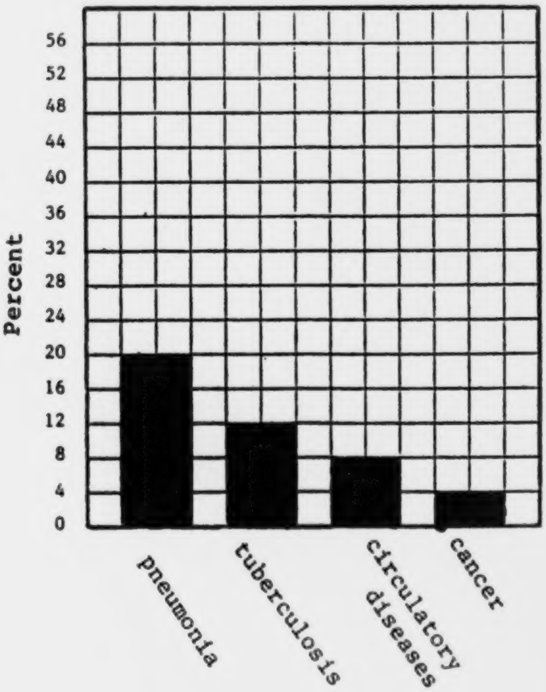
**PROBLEM:** How do the causes of death in the United States today compare to those in 1900?

**MATERIALS:** None.

**INTRODUCTION:** If you were to read an obituary column from a newpaper dated 1900, you would find the causes of death of individuals to be different than if you picked up an obituary column from a current newspaper. What were those diseases in 1900, how do the main causes of death today differ, and why has this changed, are the questions you will answering today.



Major Causes of Death in the United States in 1980



Major Causes of Death in the United States in 1900

## LABORATORY WORKSHEET 4.2 (continued)

NAME________________________________

PROCEDURE

1. What was the leading cause of death in the United States in 1900? _______

   What percentage of deaths resulted from this cause? _______

2. What was the second leading cause of death in the United States in 1900?

   ________________________________

   What percentage of deaths resulted from this cause? ________

3. What was the total percentage of people who died from both these diseases in 1900?______________

4. What was the leading cause of death in the United States in 1980? _______
   What percentage of total deaths in 1980 resulted from this cause? _______

5. What was the second leading cause of death in 1980?______________

   What was the percentage of deaths from this cause?_______________

6. What was the total percentage of people who died from both these diseases in 1980? ____________

7. What has been the pattern of change for each of these diseases from 1900 to today?

   pneumonia ________________________________

   tuberculosis ____________________________

   cancer _________________________________

   circulatory diseases ______________________

   How do you explain these changes?

   ____________________________________________________________________

   ____________________________________________________________________

   ____________________________________________________________________

## LABORATORY WORKSHEET 4.2 (continued)

NAME______________________________

8. How can the information in these graphs explain one of the main reasons people in the United States live longer today than they did in 1900?

________________________________________________

________________________________________________

________________________________________________

9. How can we explain the low incidence of circulatory disease and cancer in 1900?

________________________________________________

________________________________________________

________________________________________________

### SUMMARY/HOMEWORK

- Most of the money being spent on medical research today is being used to support investigations into circulatory diseases and cancer. Do you think this money is being well spent? Why?

# ADDITIONAL IN-CLASSROOM ACTIVITY

1. Does life expectancy vary in different countries? Explain. (To help answer this question use a current Almanac.) Compare life expectancy from 1900-1980 in the following countries:

   United States
   Soviet Union
   Sweden
   Korea
   Australia
   South Africa

2. Consider the following quote:

   > "Women live longer than men today, but within the next 20 years the life expectancies of men and women will be equal."

   Do you think there is any truth to this? Why or why not? Can we make predictions like this one with any accuracy? Explain.

3. Why do you think the life span of "early man" was so short?

4. What would be some major problems today if life expectancy increased by 30 years?

## ESSENTIAL VOCABULARY

1. breakthrough
2. disease
3. geriatrics
4. infectious
5. life expectancy
6. life span
7. noninfectious
8. symptom

# UNIT 2. NONINFECTIOUS DISEASES

# Lesson 1: HOW DO PROBLEMS WITH THE CIRCULATORY SYSTEM DEVELOP?

PERFORMANCE OBJECTIVES: The students will be able to:

- identify the major structures comprising the circulatory system (heart, arteries, veins) and their functions.
- relate the possible roles of stress and hypertension to the narrowing and blockage of arteries producing heart attacks (coronaries) and strokes.

MATERIALS: Model and/or chart of a human heart, or transparency of heart and overhead projector.

MOTIVATION: "Why is the development of an artificial human heart so important?" (Relate first successful implant of the "Jarvik heart" in 1982 [Dr. Barney Clark recipient].)

## DEVELOPMENT

1. Using models, charts, or diagrams of the human heart and circulatory system, review the basic structure of the circulatory system. Ask: "What might happen to the muscles which make up the heart if the coronary arteries become blocked?" (heart attack and/or death) "Why?"

   A heart attack occurs when a certain portion of the heart muscle does not receive enough oxygen. Without enough oxygen, the heart muscle cells die. Oxygen may not get to all the heart muscle if there is a large build-up of fatty material on the walls of the heart arteries. When an artery gets clogged with these materials, the space through which blood can flow gets smaller and smaller. As fatty material from blood builds up, the artery walls become stiff and less elastic. A blood clot can form in the narrow part of a clogged heart artery. The clot will block blood flow to a section of the heart. This may result in a heart attack.

2. Ask: "Why are some people more likely to develop diseases of the circulatory system than others?" Construct a profile of the type of person who is most likely to develop diseases of the circulatory system.

   The type A personality: age (40-50), overweight, diet high in saturated fats (cholesterol), cigarette smoking.

3. "What happens when there is a blockage of blood in an artery going to the brain?" Elicit: stroke.

4. Ask: "Have you ever had your blood pressure taken?" Elicit that the results come in two numbers. "What does 120/80 mean?"

   Each heartbeat consists of a contraction phase or systole, followed by a relaxation phase or diastole. The blood pressure in an adult human heart will rise during systole to about 120mm of mercury. During diastole, the pressure recedes to that of the blood vessels, normally about 80mm of mercury. Blood pressure readings much higher or lower than these may be a cause for concern.

## SUMMARY

1. "How might a person's circulatory system begin to malfunction?"
2. "How can you keep your circulatory system healthy?"

# Lesson 2: HOW ARE DISEASES OF THE CIRCULATORY SYSTEM DETECTED?

PERFORMANCE OBJECTIVES: The students will be able to:

- describe typical symptoms associated with the occurrence of a heart attack.
- relate the use of a stethoscope, sphygmomanometer, EKG, and taking a pulse to the state of health of the circulatory system.

MATERIALS: Stethoscope, sphygmomanometer.

MOTIVATION: "Which of the following symptoms occur in a person undergoing a heart attack?" (all of them)

a. sudden, sharp pain over the heart best described as squeezing, pressing, or vise-like
b. shortness of breath
c. indigestion
d. pain moving to the left shoulder, arm, elbow, or fingertips
e. skin becoming ashen or grey as in shock
f. skin clammy, moist and cold ("cold sweat")

"How does a doctor know whether these are related to circulatory diseases?"

* **NOTE TO TEACHER:** Structure of heart and circulatory system covered in Grade 8 curriculum pp. 223-238.

DEVELOPMENT

1. Ask: "How does the doctor determine whether a person complaining of the above symptoms is having a heart attack?"

2. Ask: "Why does a doctor listen to a person's heart with a stethoscope?" (Demonstrate the stethoscope. Have students try it on themselves or on the back of a partner. Play a "Lub-dub" record if available.) Describe the sounds the doctor hears.

3. Display and/or demonstrate a sphygmomanometer. Ask: "What is it used for?" Introduce the terms hypertension and high blood pressure.

4. Ask: "How can a doctor, using only a person's lower arm, determine how fast that person's heart is pumping blood through the arteries?"

5. Have students practice taking their own pulse. Ask: "How would you expect a person's heart rate to change after exercise?" "Why?" [Caution: Do NOT do this as a classroom activity since a student may have a heart problem.] Collect data on pulse rate from many students and establish an average and a range.

6. Ask: "Why is an EKG (electrocardiogram) an important part of an adult's medical examination?" An EKG gives a record of the electric current produced by a beating heart.

## SUMMARY

1. "Why might it be important that a person with the various symptoms described at the beginning of today's class period be seen by a doctor?"
2. "How can a doctor check to see if your circulatory system is working correctly?"

## FOR FURTHER THOUGHT

- "Why can't these instruments and techniques be used to predict the future health of a person's circulatory system?"

## ADDITIONAL IN-CLASSROOM ACTIVITIES

1. Arrange a current events bulletin board to demonstrate the current advances made in medical technology. Have students bring in summarized articles relating to these advances (i.e., artificial human heart).
2. "Why would a 65-year-old man be taking a chance with his health if he decided to shovel snow off the sidewalk on a cold winter morning?"
3. "Why is it important, when you begin exercising, to start off with moderate exercise and then work your way up?"
4. "Each pound of excess fat on your body adds 3,000 miles of capillaries (the distance from New York to California) to your circulatory system. How does this affect your heart?"

### ESSENTIAL VOCABULARY

asbestos

benign

biopsy

circulatory system

compare

detect

hypertension

malignant

metastasized

sphygmomanometer

stethoscope

technology

tumor

## Lesson 3: WHAT IS CANCER?

PERFORMANCE OBJECTIVES: The students will be able to:

- contrast normal cells with abnormal cells typical of cancer.
- list the early warning signs of cancer.

MATERIALS: None.

MOTIVATION: "What does the warning printed on a cigarette package say?"
"Why is there concern over cigarette smoking?"

DEVELOPMENT

1. Ask: "What is cancer?"

   Cancer is a large group of diseases characterized by uncontrolled growth and spread of abnormal cells. If the spread is not controlled or checked, it could result in death. However, many cancers can be cured if detected and cured promptly.

2. Ask: "Why is it important that the cells of our bodies have the ability to reproduce and make more of themselves?" (the repair of damaged or worn-out cells)

3. Ask: "How are the cell divisions of cancer cells different from normal cell divisions?"

   Occasionally, certain cells undergo an abnormal change and begin a process of uncontrolled growth and spread. One cell divides into two, those redivide into four, and so on. These cells may grow into masses of tissue called tumors--some benign (harmless) and others malignant (cancerous).

   The danger of cancer is that it invades and destroys normal tissue. At the beginning, cancer cells usually remain at the original site, and the cancer is said to be localized. Later, some cancer cells may invade neighboring organs or tissue. This occurs either by direct extension or growth or by becoming detached and carried through the lymph or blood systems to other parts of the body. This is called metastasis of a cancer. The spread may be regional or it can spread throughout the body. That condition is known as advanced cancer, and usually results in death.

   Because with each stage a case of cancer becomes progressively more serious, it is important to detect cancer as early as possible. Aids to early detection include cancer's Seven Warning Signals.

4. Discuss the Seven Warning Signals of cancer.

    I. Change in bowel or bladder habits.
    II. A sore that does not heal.
    III. Unusual bleeding or discharge.
    IV. Thickening or lump in breast or elsewhere.
    V. Indigestion or difficulty in swallowing.
    VI. Obvious change in a wart or mole.
    VII. Nagging cough or hoarseness.

SUMMARY

1. "Why should all adults over the age of 40 have yearly physical examinations by a doctor even if they feel fine?"
2. "Why might people who have one or more of the danger signs of cancer, and who know what these signals mean, still not go to a doctor?"

# Lesson 4: HOW CAN CANCER BE CONTROLLED?

PERFORMANCE OBJECTIVES: The students will be able to:

- describe the current concern over the role of environmental agents in the start of cancers.
- identify methods of treatment and prevention of cancer.

MATERIALS: Laboratory Worksheet 4.3, article "The Prevention of Cancer."

MOTIVATION: "In 1971, about 750,000 people died due to cancer. Authorities believe 250,000 of these deaths should not have occurred. What does this mean?"

DEVELOPMENT

1. Distribute the article, "Looking Ahead: The Prevention of Cancer." Ask: "What appear to be some of the major causes of cancer?" Discuss the causes outlined in the article, then have students complete the worksheet.

2. Ask: "How can a malignant growth or tumor be removed or destroyed?" Introduce the methods of cancer treatment:

   a. Surgery - is successful in treating a great percentage of cancer patients. Improved operating procedures and advancements in pre- and post-operative care have contributed to the greater safety and effectiveness of even the most agressive cancer surgery.

   b. Radiation - doses to cure cancer must be large enough to destroy the cancer cells, but not so great as to seriously damage normal tissue surrounding or overlying the cancer. Some cancers may be deep-seated, and conventional radiotherapy would seriously harm overlying organs. Radiation suitable for cancer therapy can be produced by electrically generated X-rays, by gamma rays emitted from radioactive isotopes (atomic particles derived from radioactive material), and by electrons, protons and neutrons.

c. Chemotherapy - is used with certain types of widespread cancer that cannot be cured by surgery or radiation. These types of cancers are treated with drugs or chemicals that can destroy cancer cells without harming normal healthy tissue. In about 15% of clinical cancers, the drugs can produce cures; in many of the remainder they often temporarily inhibit the cancerous growth, relieve pain, and allow the patient to live a longer, more comfortable life.

The administration of drugs is limited by their side effects such as impaired production of blood cells; temporary loss of hair; and nausea, vomiting, and diarrhea.

d. Immunotherapy - involves scientists who are trying to find out if they can use the body's natural defense, its immunological system, to control cancer. This system consists of specialized groups of cells that recognize and reject some foreign substances by producing specific counter-substances.

3. Ask: "Why are we concerned that the environment may be a cause of cancer?" Distribute the article, "Looking Ahead: The Prevention of Cancer." Discuss how environmental agents can cause cancer. Have students summarize article for homework.

## SUMMARY

1. "Why is there so much concern about building nuclear power plants near population centers?"

2. "Why are people who were exposed to asbestos and radium paint many years ago described as 'walking time bombs'?"

## LABORATORY WORKSHEET 4.3

### Prevention of Cancer

A dramatic reduction in the rate of cancer is now possible, thanks to a shift of emphasis towards prevention. A prevention program could cut cancer as much as 50%. The view is now widely held that a large majority of cancers--perhaps as much as 90%--is caused by exposure to environmental chemicals.

#### CAUSES OF CANCER: RADIATION

This showed up as early as the 1920s in the illness of workers painting radium on watches. The survivors of atomic bomb attacks on Hiroshima and Nagasaki suffer a high rate of leukemia and breast cancer.

#### CAUSES OF CANCER: TOBACCO

Modern research has identified at least seven carcinogens in tobacco smoke and found that 80% of all lung cancer is due to cigarette smoke.

#### CARCINOGENS IN THE WORKPLACE

A study by the National Cancer Institute and National Institute of Environmental Health Sciences found that at least one of every five future cases of cancer will come from exposure to carcinogens on the job. The worst offender seems to be asbestos, with the number of cancers related directly to asbestos exposure reaching an estimated 67,000 each year during the next 30-35 years .

**Some other examples:**

- Rubber workers, exposed to multiple-cancer causing substances, such as vinyl chloride, are dying of cancers of the stomach and prostate and of leukemia and other cancers of the blood and lymph forming tissues at "rates ranging from 50% to 300% greater than in the general population."
- Steelworkers handling coal at coke ovens have excessive rates of lung cancer.
- Workers in dye factories using benzidene and other aromatic amines have a high rate of bladder cancer.
- Miners of uranium, iron ore, nickel, chromium and other industrial chemicals are likely to get industry-related cancers. Fifty percent or more of uranium miners die of lung cancer.
- About two million workers, including dry cleaners, painters, printers and rubber and petroleum workers, are exposed to the solvent benzene, identified as a leukemia-producing agent.
- Another 1.5 million workers, handling insecticides and working in copper and lead smelters, are exposed to inorganic arsenic, a carcinogen related to lung and lymphatic cancer.

In addition, chemical carcinogenic wastes from industry are leaking into food, water, and the air. Measurable amounts of PCB were found in the milk of almost one-third of all nursing mothers tested in 1975.

Abstracted from "Health," Social Issues Resources Series, Vol. 2, Article 5.

# LABORATORY WORKSHEET 4.3 (continued)

NAME______________________________CLASS_______________DATE_______________________

DIRECTIONS: Based on the article, "Prevention of Cancer" answer the questions which follow.

1. How can the number of cancer cases in the future be reduced?

2. What do scientists believe causes cancer?

3. What are carcinogens?

4. What effect did the atomic bomb have on the people of Hiroshima and Nagasaki?

## LABORATORY WORKSHEET 4.3 (continued)

NAME________________________________

5. Explain the following in a brief paragraph: Technological advances improved our lives with new products. Are we paying the price of progress with our lives and health?

## Questions for Review

NAME______________________________ CLASS_________ DATE _____________________

1. Asbestos, fiberglass, insulation, coal dust and tobacco smoke have been linked to cancer of the:
    - a. lung
    - b. stomach
    - c. breast
    - d. large intestines

2. The spreading of cancer to other places in the body is called:
    - a. embolism
    - b. stroke
    - c. metastasis
    - d. carcinogen

3. Cancerous growth can be treated by:
    - a. radiation therapy
    - b. chemotherapy
    - c. surgery
    - d. all of these

4. A sample of a growth that is examined under a microscope is called a(n):
    - a. autopsy
    - b. biopsy
    - c. electrocardiogram
    - d. slide

5. In a cancerous growth:
    - a. cell division is slower
    - b. cells are highly specialized
    - c. cells interfere with normal cell functioning
    - d. all of these

6. The combination of high blood pressure and arteriosclerosis can lead to:
    - a. heart failure
    - b. stroke
    - c. blood clot
    - d. all of these

7. High blood pressure is most directly related to:
    - a. arteriosclerosis
    - b. cancer
    - c. regular exercise
    - d. environmental pollutants

NAME_______________________________

8. Which of the following is a normal blood pressure reading for a healthy adult?:
   a. 80/120
   b. 120/80
   c. 50/100
   d. 100/150

9. Which of the following is not usually a symptom of a heart attack?:
   a. indigestion
   b. breaking out in a cold sweat
   c. pain in the right arm
   d. shortness of breath

10. The percentage of deaths due to circulatory disease now, as compared to the percentage of deaths due to ciruclatory disease in 1900:
   a. is more
   b. is less
   c. is the same
   d. cannot be compared

11. Circulatory diseases includes:
   a. high blood pressure
   b. stroke
   c. heart attack
   d. all of these

12. Smoking is least associated with cancers of the:
   a. stomach
   b. mouth
   c. throat
   d. lung

13. The pulse rate and the heartbeat:
   a. differ from each other when we sleep
   b. are always the same
   c. differ from each other in children
   d. differ from each other when we exercise

14. Fatty deposits that buildup inside arteries can cause:
   a. increased blood flow
   b. mismatched blood types
   c. immunity
   d. heart attacks and strokes

15. An abnormal growth of cells which is harmless is said to be:
   a. malignant
   b. cancerous
   c. benign
   d. carcinogenic

NAME________________________________________

Matching -- Choose the number of the item from Column B which best matches each item in Column A.

Column A

16. _____ The number of times per minute an artery contracts.
17. _____ Blood pressure cuff.
18. _____ Shows the pattern of contraction of the heart.
19. _____ Used to listen to heart sounds.
20. _____ A measure of blood pressure when the heart is at rest.

Column B

a. sphygmomanometer
b. stethoscope
c. electrocardiogram
d. pulse rate
e. systolic
f. diastolic

True or False

21. _____ Smoking can increase blood pressure.
22. _____ Your weight has no effect on your blood pressure.
23. _____ Your pulse rate changes with the activity your engaged in.
24. _____ Veins carry blood away from the heart.
25. _____ Diet has no effect on cancer.
26. _____ Stress has no effect on cancer.
27. _____ Tars in cigarette smoke are carcinogenic.
28. _____ A cancerous growth is called benign.
29. _____ Cancer is the major cause of death today.
30. _____ The highest percentage of deaths due to cancer occur in the over 65 age group.

NAME________________________________________

Essay

31. Why may a person's circulatory system begin to malfunction?

32. What do we mean by pulse rate?

33. What is cancer?

34. Write a well organized paragraph in which each of the following terms is used correctly:

benign
malignant
carcinogen
tumor
biopsy

# UNIT 3. INFECTIOUS DISEASES

* **NOTE TO TEACHER:**

Lessons 1, 2 and 3 are optional. In schools where microscopes are available the teacher may wish to do these lessons. Where microscopes are not available the teachers are to begin Unit 3 with Lesson 4, "How Can Our Environment Make Us Sick?"

Students are taught how to use the microscope in Grade 7. Refer to pages 113-168 of the Grade 7 curriculum guide.

Lesson 4 calls upon the teacher to complete Step 1 of the Development at least four days prior to teaching the lesson.

## Lesson 1: HOW IS A MICROSCOPE CONSTRUCTED?

[Optional]

* **NOTE TO TEACHER:** This lesson may require more than one period.

PERFORMANCE OBJECTIVES: The students will be able to:

. identify and give a function for each part of the microscope.
. set up a microscope.
. determine the total magnification of a microscope.

MATERIALS: Laboratory Worksheet 4.4.

MOTIVATION: "Imagine science prior to the year 1665, before any one knew of the existence of bacteria, blood cells, and single-celled plants and animals. What was needed before these things could be discovered?" (microscopes)

DEVELOPMENT

1. Demonstrate the proper method for carrying a microscope and review the rules in Procedure 1 of Laboratory Worksheet 4·4.

2. Look out for and assist any students having difficulty.

3. After giving the students time to perform the tasks on their own, have student volunteers demonstrate the correct way to determine the total magnification, obtain light, and set up the microscope.

SUMMARY

. Refer to Laboratory Worksheet 4.4.

# LABORATORY WORKSHEET 4.4

NAME______________________________ CLASS______________ DATE______________

PROBLEM: How do we use the microscope?

INTRODUCTION: Many of the secrets of life have been revealed with the aid of the microscope. Hopefully, once you learn how to use the microscope, a new and fascinating world will open for you.

MATERIALS: Microscope, lens paper, charts of microscope.

PROCEDURE

1. The microscope is an expensive instrument that must be used with proper care. Whenever you use a microscope you must always keep in mind the following basic rules:

    a. Always carry or lift the microscope using both hands; one hand on the arm, the other hand under the base.

    b. Always place the microscope in the center of your table with the arm towards you.

    c. Never touch or clean the lenses with anything except special lens paper.

    d. Before putting the microscope away, turn the nosepiece so none of the objectives are in line with the body tube. This is called the neutral position.

    e. As you learn to use the microscope, there will be other safety rules that you will learn.

2. You are now ready to get your microscope. Follow the rules learned in Procedure 1. When you have your microscope properly placed in front of you, begin to read the next paragraph.

    Read the following selection, then answer the questions.

    The microscope which you are using is called a light compound microscope. It is called a light microscope because it uses light as its source of energy. The parts of the microscope which furnish light or direct it into the microscope are called the illuminating parts. Microscopes use lenses to magnify objects. Your microscope is called a compound microscope because it contains two or more sets of lenses. The parts of the microscope which help magnify the object are called the optical parts. The parts which help support it and focus it are called the mechanical parts.

# LABORATORY WORKSHEET 4.4 (continued)

NAME ______________________________

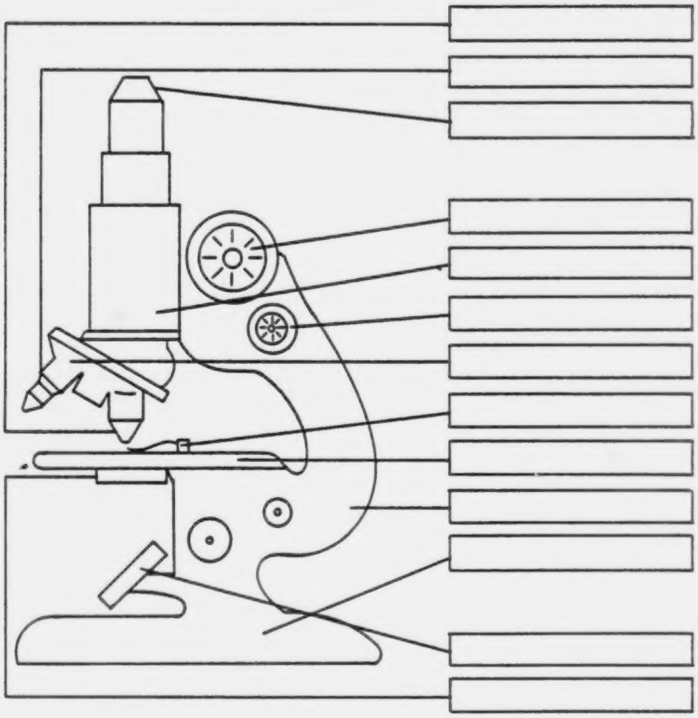
As you read the description of the parts of the microscope, locate each part on your microscope. When you are sure that you have correctly located a part write in its name on the diagram of the microscope. It is important not to move any of the parts of the microscope.

It is best to try to locate each part from the description alone. If you are having a great deal of difficulty it is all right to use the charts or diagrams that your teacher can provide for you.

a. Write a definition of the light compound microscope. _____________

_______________________________________________________________________

b. Fill in the boxes of the microscope diagram according to optical, mechanical, and illuminating parts. Do this as you read about the parts of the microscope.



# LABORATORY WORKSHEET 4.4 (continued)

## Parts of the Microscope

NAME______________________________

I. The Illuminating Parts

A. Mirror - The mirror is arranged so that it can reflect light up through the microscope. Your mirror may have both a flat side and a (concave) curved side. It is best to use the flat side for light coming from a distance (windows), while the concave side is best for light from a nearby lamp.

B. Diaphragm - The diaphragm is located on the underside of the microscope above the mirror. The diaphragm regulates the amount of light that reaches the microscope. It may be a disk with holes of different sizes, or it may be an adjustable iris which gets larger or smaller as a lever is moved.

II. The Optical Parts

A. Eyepiece - The eyepiece is a combination of lenses at the top of the microscope. It is the part of the microscope which you look into.

B. Objectives - These are the sets of lenses located at the bottom of the tube. There are at least two objectives on your microscope. The larger one is called the high power objective. The shorter one is the low power objective.

III. The Mechanical Parts

A. Base - A heavy base supports the microscope and enables it to stand upright on your table.

B. Arm - The arm is the part of the microscope which looks like a handle and can be used to carry the microscope.

C. Stage - The stage is a platform on which the specimen rests. The stage has a round hole in its center through which light can pass.

D. Stage Clips- These are small metal clips which are located on the stage. They are used to hold the glass slides in place.

E. Body Tube - A long tube which holds the eyepiece lenses.

F. Nosepiece - The nosepiece holds the objectives. It can be rotated to change from one objective to another.

G. Coarse Adjustment Knob - A large knob or wheel used to focus the microscope.

H. Fine Adjustment Knob - The small knob or wheel that enables you to make small adjustments and obtain the clearest focus possible.

## LABORATORY WORKSHEET 4.4 (continued)

NAME_____________________________

3. Now you are ready to learn how to use the microscope. Be sure to carefully follow all the instructions. Write in the answers to the activities in the space provided.

The Optical Parts

a. Examine the eyepiece at the top of the microscope. What is written on the eyepiece?______________________________________________

b. What do the numbers tell you about the function of the eyepiece?

_____________________________________________________________

c. Locate the objectives on the nosepiece at the bottom of the body tube. Examine the two (2) objectives carefully and indicate on the chart below two (2) ways you can tell the low and high power objectives apart.

| Low Power | High Power |
|---|---|
| | |
| | |

d. How can you switch from one objective to another?_________________

_____________________________________________________________

e. How do you know if your objective is in the correct position for viewing?__________________________________________________

_____________________________________________________________

Practice switching from low power to high power. When you are finished leave the low power objective in place.

Determining Total Magnification

The total magnification of a microscope is equal to the magnification of the eyepiece times the magnification of the objective being used.

a. Determine the total magnification of your microscope for low power.

Low power objective X Eyepiece = Total Magnification

_______________ X _______ = _______________

NAME________________________________

b. Determine the total magnification of your microscope for high power.

High power objective X Eyepiece = Total Magnification

____________________ X ________ = ___________________

4. The Illuminating Parts

a. Examine the mirror and see in which directions it swivels.

b. Turn the mirror to the correct side, depending on your light source (the flat side for light coming from a distance through windows; the curved (concave) side for light from a nearby lamp).

c. Use the mirror to direct light to the tip of the low power objective. CAUTION: NEVER USE DIRECT SUNLIGHT FOR LIGHTING THE SUBJECT YOU ARE VIEWING. IT MAY CAUSE PERMANENT DAMAGE TO YOUR EYES.

d. Look into the eyepiece. Describe what you see.______________________

________________________________________________________________________

e. The area that appears is called the field of vision. Try turning the mirror slightly, until the brightest field of vision is obtained.

f. While looking through the eyepiece turn the diaphragm slowly to the left and right. What happens to the field of vision as you do this?

________________________________________________________________________

________________________________________________________________________

5. The Mechanical Parts

a. Find the coarse adjustment knob. Turn the coarse adjustment knob slowly towards you. In what direction did the body tube move?

________________________________________________________________________

________________________________________________________________________

b. Turn the coarse adjustment knob slowly away from you. In what direction did the body tube move?

________________________________________________________________________

________________________________________________________________________

## LABORATORY WORKSHEET 4.4 (continued)

NAME________________________________

CAUTION: YOU SHOULD NEVER TURN THE COARSE ADJUSTMENT KNOB AWAY FROM YOU WHILE LOOKING THROUGH THE EYEPIECE.

c. Why is this an important safety rule to remember?____________________

________________________________________________________________

d. Turn the fine adjustment knob slowly toward you and away from you, while looking through the body tube. Does the body tube move?_______

The body tube actually did move, but such a small distance that it was impossible for your eye to see it.

CAUTION: NEVER TURN THE FINE ADJUSTMENT KNOB MORE THAN ONE TURN IN EITHER DIRECTION.

SUMMARY/HOMEWORK

1. Indicate the location and functions of each of the following parts:

a. stage:____________________________________________________

________________________________________________________________

b. arm: ____________________________________________________

________________________________________________________________

c. base: ____________________________________________________

________________________________________________________________

d. stage clips:______________________________________________

________________________________________________________________

e. body tube:________________________________________________

________________________________________________________________

## Lesson 2: HOW IS THE MICROSCOPE PROPERLY USED?

PERFORMANCE OBJECTIVES: The students will be able to:

- bring an object into focus under the low power of the microscope.
- bring an object into focus under the high power of the microscope.

MATERIALS: See Laboratory Worksheet 4.5.

MOTIVATION: (Refer back to the lesson on convex lenses [Theme II, Unit 3].) "How will the microscope change the appearance of an image?"

DEVELOPMENT

1. Guide students through Laboratory Worksheet 4.5.
2. Demonstrate the proper method of focusing under both low power and high power. Caution the students to never use the coarse adjustment knob when viewing under high power.

SUMMARY

- See Laboratory Worksheet 4.5.

# LABORATORY WORKSHEET 4.5

NAME________________________________ CLASS______________ DATE______________

PROBLEM: How is the microscope properly used?

INTRODUCTION: You are now ready to use your microscope to observe an object. Follow the directions carefully, and perform the activities as directed. If you have any difficulty, remember to ask your teacher for help.

MATERIALS: Microscopes, letter "e" slides, assorted optional slides (blood cells, plant cells, animal cells, etc.)

## PROCEDURE

1. Setting up the Microscope under Low Power

    a. Set the microscope up for use under LOW power.

    b. Ask your teacher for a prepared slide of the letter "e." Place the slide of the letter "e" on the stage of the microscope so that you can read the letter "e" in its normal position. Be sure that the letter "e" is placed in the center of the stage. Secure the slide to the stage by means of stage clips.

    c. While looking at the microscope from one side, slowly turn the coarse adjustment knob away from you to lower the body tube, until the objective is almost touching the slide.

    d. Look through the eyepiece and while doing so, turn the coarse adjustment knob VERY SLOWLY toward you until the letter "e" comes into focus. (If you do not succeed start over again). Use the fine adjustment to sharpen the focus.

    e. In the space provided, draw the letter "e" as it appears under the low power of the microscope.

The Letter "e" as seen under Low Power

## LABORATORY WORKSHEET 4.5 (continued)

NAME________________________________

f. How does the letter "e" as viewed under the microscope differ from the letter "e" that you see with your naked eye?

________________________________________________________________

________________________________________________________________

2. The Movement of an Image Under the Microscope

   a. Move your slide to each of the positions listed below and indicate in which direction the image moves.

      Move slide to the right — Image moves to the______________

      Move slide to the left — Image moves to the ______________

      Move slide towards you — Image moves____________________

      Move slide away from you — Image moves____________________

   b. Make a general statement about the movement of the image under a microscope.

________________________________________________________________

________________________________________________________________

3. Setting up the Microscope under High Power

   a. After you have completed the previous activities, carefully turn the nosepiece until the high power objective clicks into place. (NOTE: There should be no difficulty in doing this if your microscope is in good condition. On some old microscopes, however, it may be necessary to raise the body tube a little to prevent the high power objective from hitting the slide.)

   b. While looking through the microscope, use the fine adjustment knob to bring the image into focus. (CAUTION: YOU SHOULD NEVER USE THE COARSE ADJUSTMENT KNOB WHEN VIEWING UNDER HIGH POWER.) Since high power requires more light than low power it may be necessary to adjust the mirror or diaphragm again in order to get the greatest amount of light.

   c. If necessary move your slide to center your letter "e." It may be necessary to go back to low power if you cannot find the letter "e". (NOTE: Remember that if an object is not centered and focused under low power first, you will not be able to see it under high power).

## LABORATORY WORKSHEET 4.5 (continued)

NAME______________________________

d. Why should you never use the coarse adjustment knob when viewing an object under high power?

______________________________________________________________________

______________________________________________________________________

e. In the space provided, draw the letter "e" as it appears under the high power of the microscope.

The letter "e" as seen
under High Power

b. How does the image under high power differ from the image under low power?____________________________________________________________

______________________________________________________________________

6. (Optional) Ask your teacher to give you the set of glass slides which have on them some of the things Leeuwenhoek originally discovered.

SUMMARY/HOMEWORK

1. Given a prepared slide of a tiny organism, briefy describe how you would locate the organism under high power.
2. Explain why objects are frequently lost when switching from low power to high power.

## Lesson 3: HOW CAN WE OBSERVE BACTERIA UNDER THE MICROSCOPE?

[Optional]

PERFORMANCE OBJECTIVES: The students will be able to:

- use a simple stain to prepare a slide of bacteria.
- identify several types of bacteria seen under the microscope.

MATERIALS: See Laboratory Worksheet 4.6.

MOTIVATION: "How can a container of yogurt be used to study bacteria?"

DEVELOPMENT

1. Guide students through Laboratory Worksheet 4.6.
2. Demonstrate the proper method of placing a cover slip on a microscope slide.
3. Explain that the two bacteria often seen in yogurt are lactobacillus bulgaricus (rods) and streptococcus lacti (strings of spheres).
4. Instruct students to look for bacteria in the clear areas among the darker globules of coagulated milk.

* **NOTE TO TEACHER:** Cultures of harmless bacteria can be obtained from biological supply houses. These can be used for pupils to prepare slides.

SUMMARY

- See Laboratory Worksheet 4.6.

* **NOTE TO TEACHER:** The following is an alternate procedure which may be used to take the place of Procedures 1a - 1d in Laboratory Worksheet 4.6:

1. Prepare a permanent slide as follows:
   a. Place a dropful of yogurt on a clean slide.
   b. Spread this small drop into a thin film and let it dry in the air.
   c. When the film is dry, pass the bottom of the slide through a flame three times to fix the bacteria to the slide, so that they will not be washed off in the subsequent staining procedure.
   d. Apply methylene blue to the slide for 2 to 4 minutes, then wash off with water and blot dry. Coverslips need not be used.

Continue with Procedure 1e.

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# LABORATORY WORKSHEET 4.6

NAME______________________________ CLASS______________ DATE______________

PROBLEM: How can we observe bacteria under the microscope?

INTRODUCTION: Bacteria are the most numerous organisms on the earth. They are also the smallest and the simplest in structure. Since they are normally colorless, slides of bacteria are frequently stained. Stains color cells and make them easier to observe.

None of the bacteria you observe should be harmful, but whenever you study bacteria you should be careful and treat all bacteria as if they cause disease.

MATERIALS: Microscope, slides, cover slips, medicine dropper, methylene blue solution, a container of plain yogurt, prepared slides of bacteria, lens paper, test tubes, chart of shapes of bacteria.

PROCEDURE

1. Examination of yogurt.

   a. Place a drop of methylene blue stain on a carefully cleaned slide and allow to dry for three minutes.

   b. In a clean test tube add 1 drop of yogurt to 9 drops of water. Mix well.

   c. Add a drop of the diluted yogurt to the stained slide.

   d. Place a cover slip on the slide and observe under low power of the microscope.

   -- Why is it not possible to see any bacteria under low power?

   ________________________________________________

   -- Carefully switch to high power. (Remember the precautions to be used when viewing under high power.)

   e. In the space below draw what you see under the microscope.

## LABORATORY WORKSHEET 4.6 (continued)

NAME

f. Bacteria are classified by the shapes. Bacteria within these classifications are also known by the different groupings in which they are found.

| SHAPE | ARRANGEMENT |
|---|---|
| round (coccus) | pairs (diplo) |
| rod (bacillus) | chains (strepto) |
| spiral (spirillum) | clusters (staphylo) |

Try to identify and name any bacteria which you observe.

g. Do the bacteria move?

Describe this motion.

What do you think is responsible for this motion?

2. (If available) Observe the prepared slides of bacteria.

How do they differ from the slides of yogurt you observed?

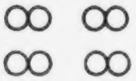
SUMMARY/HOMEWORK

1. What are the advantages and disadvantages of staining bacteria?

# LABORATORY WORKSHEET 4.6 (continued)

NAME______________________________

2. Identify each of the following types of bacteria by its form and arrangement.



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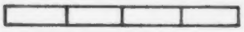

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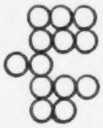

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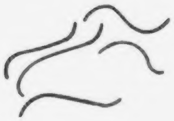


______________________________

3. Why do you think it took so long to make a connection between bacteria and disease?

______________________________________________________________________

______________________________________________________________________

## Lesson 4: HOW CAN OUR ENVIRONMENT MAKE US SICK?

PERFORMANCE OBJECTIVES: The students will be able to:

. associate the environment with the presence of different microorganisms.
. relate disease to harmful microorganisms.
. observe the rapid spread of a substance through a population.

MATERIALS: Flourescein (or any fluorescent stain), four petri dishes with active colonies, four sterile petri dishes, ultraviolet light, demonstration microscopes with oil immersion lenses, prepared slides of different forms of bacteria (if available). (Optional) unpasteurized yogurt, water, glass rod, slide, cover slip, bacterial charts.

MOTIVATION: "Why should we wash our hands before eating?" (This should lead to suggestions of illness.)

DEVELOPMENT

1. About four days before this lesson, expose four agar-containing sterile petri dishes to the air. Seal and incubate until colonies form. Before class meets, lightly coat the sides of two petri dishes with flourescein stain (prepared by stirring 0.5 g of flourescein in 15 ml of glycerol until fully dissolved).

2. Exhibit the petri dishes to the class and briefly explain the procedure for preparation. Ask: "How can these dishes be used to answer our question?" Pass the dishes among the students. Introduce the term microorganism. Ask: "Why are they called microorganisms and not germs?" Caution students not to open petri dishes.

   Microorganism -- any living organism that is so small that it can only be seen with a microscope.

3. Use demonstration microscopes (and/or charts) to show some prepared slides of bacteria. Introduce the concept that most microorganisms are not harmful (pathogenic) and therefore, don't cause disease. (You may now want to show the presence of bacilli in yogurt.)

   Pathogen -- a disease causing organism.

4. "What are the types of bacteria?"

   Show a chart of three main types of bacteria (such as those on Laboratory Worksheet 4.6). Identify and name each type. Associate one or two diseases with each type:
   bacillus -- TB, tetanus
   coccus -- strep throat, gonorrhea
   spirillum -- syphilis, cholera

5. Ask: "Does washing our hands make a difference?" To show how pathogenic microorganisms can be distributed, expose the students' hands to an ultraviolet (black) light in a darkened area. (In addition to bacteria, you may want to mention viruses and fungi.)

   Virus -- Viruses are not cells and are not made of cells, but are merely genetic material in a protein coat. By themselves, viruses do not reproduce, respond to changes, use energy or grow. However, when a virus enters a living host cell, the virus is able to reproduce by using material from the host cell.

   Fungi -- Fungi are plants that do not contain chlorophyll. Some kinds of fungi can cause disease. Among the infections caused by fungi are ringworm and athlete's foot.

## SUMMARY

1. "Why should you wash your hands thoroughly?"
2. "When someone in your house has a sore throat, how can you reduce the chance of the disease spreading among other members of the family?"

## FOR FURTHER THOUGHT

1. "How do beneficial bacteria help us in our daily lives?"
2. "Why can't bacteria grow in an empty sterilized petri dish?"

## Lesson 5: WHERE DO WE FIND BACTERIA IN THE SCHOOL?

PERFORMANCE OBJECTIVES: The students will be able to:

- recognize the presence of bacteria on objects in the classroom.
- perform procedures needed to culture bacteria.

MATERIALS: Laboratory Worksheet 4.7, two sterilized petri dishes per group, grease marking pencils, sterile cotton swabs, incubator, a petri dish showing colonies, adhesive tape.

MOTIVATION: "How can we see bacteria without a microscope?"

DEVELOPMENT

1. Distribute Laboratory Worksheet 4.7 and review safety procedures to follow when working with bacteria.
2. For Laboratory Procedure 1, assign a code to each group to indicate both the class and group.
3. For Procedure 4 on students' Laboratory Worksheets, you may want to use a variety of classroom items and assign a different item to each lab group.
4. After collecting the petri dishes, ask: "What should we now do with the petri dishes to insure bacterial growth?" Review requirements for growth and introduce the term incubate. Demonstrate an incubator.
5. Have class predict which one of the sources used in the laboratory will contain the most bacteria and which will contain the least. Ask: "How will the petri dishes help us answer these questions?" (Show petri dish with colonies.)

SUMMARY

- See Laboratory Worksheet 4.7.

# LABORATORY WORKSHEET 4.7

NAME______________________________ CLASS____________ DATE____________

PROBLEM: Where do we find bacteria in the school?

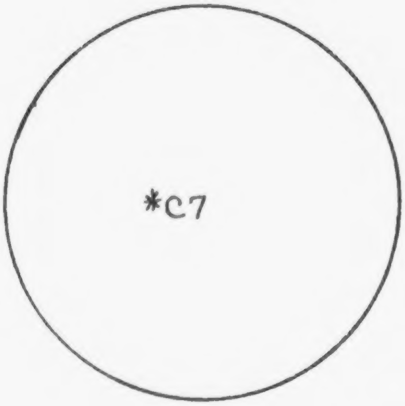
MATERIALS: Two sterilized petri dishes, marking pencil, sterile cotton swabs, scotch tape.

INTRODUCTION: Bacteria are everywhere. Unless you get an infection or grow them on a specially prepared medium, such as agar, you may not be aware of them. When grown on an agar plate they produce colonies. These eventually become large enough to be seen by the unaided eye. In this investigation you will be observing some of the growth forms of various bacteria.

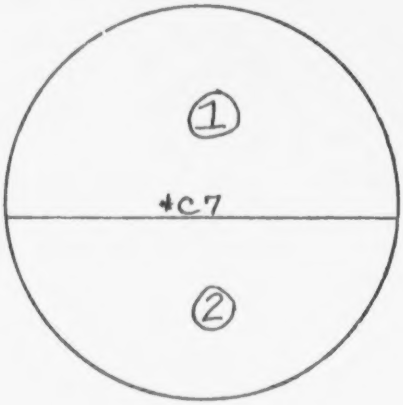
PROCEDURE

1. Carefully turn the two sterilized petri dishes bottom side up (so that the agar is facing you) on your laboratory table. DO NOT open the dishes.

2. Your teacher will give you a group code. Write your code in the center of each dish (see below). Divide one of the dishes, by drawing lines, into two halves. Number the top half "1" and the bottom half "2" so that it looks like the dish in Diagram B below.



A



B

Write your group code here __________

# LABORATORY WORKSHEET 4.7 (continued)

NAME________________________________

3. Turn dish A right side up. Gently lift the cover and expose the dish to the air for about five minutes near an open window. Then replace the cover and seal the dish with tape.

4. Turn dish B right side up. Use a different cotton swab for each of the following procedures: [Note: Read both a and b before proceeding.]

   a. Rub a swab over your desk top. Then, gently roll the swab over Area 1 of the petri dish, being careful not to press the swab into the agar.

   b. Rub a swab over your hair. Then, gently roll this swab over Area 2, being careful not to press the swab into the agar. Seal your dish.

5. Throw all used swabs into the wastepaper basket.

6. Incubate petri dishes at 37°C for at least 24 hours.

SUMMARY/HOMEWORK

1. "Why must we wait at least 24 hours before using the petri dishes for observations?"

2. "Why do we have to keep the petri dish at 37°C?"

## Lesson 6: WHY DO BACTERIA LIVE WITH US?

PERFORMANCE OBJECTIVES: The students will be able to:

- list the conditions bacteria need for growth.
- trace the modes of infection from the environment to us.

MATERIALS: Petri dishes of growing bacteria.

MOTIVATION: "Considering the results of Laboratory Worksheet 4.7, would you expect to find more bacteria growing on your hair or on objects in the classroom?" "Why?"

DEVELOPMENT

1. Elicit a list of needs for all living things to live and grow (food, oxygen, water, warmth, shelter, etc.) Ask: "How did we provide for the needs of bacteria with petri dishes?" and, "How does our hair provide for bacteria's needs?"

2. Discuss the various ways that bacteria can get to our bodies. Introduce the term infectious. Stress that bacteria can be transferred directly from one person to another or indirectly through an intermediary. Tell the story of Typhoid Mary (a cook in Chicago in the early 1900s who was a carrier and was responsible for at least ten typhoid outbreaks). Ask: "By what means could Mary have infected people?" and, "How else can bacteria be transmitted?" (insects such as flies, fleas, roaches, and bedbugs)

3. Ask: "How can bacteria enter our bodies?" Explain routes such as the respiratory and genital tracts, the mouth, nose, skin, and open wounds.

SUMMARY

1. "Why are our bodies like a petri dish to bacteria?"

2. "Why should you cover your mouth when you cough?"

FOR FURTHER THOUGHT

1. "Select three modes of bacterial infection and state how you could become infected."

2. "Why is it better to let dishes air-dry rather than to use a dish towel?"

## Lesson 7: HOW CAN WE CONTROL BACTERIAL POPULATION?

**PERFORMANCE OBJECTIVES:** The students will be able to:

- list materials and procedures that kill or retard the growth of bacteria.
- compare the effectiveness of disinfectants and antiseptics.
- identify the three main types of bacteria.

**MATERIALS:** See Laboratory Worksheet 4.8,chart showing types of bacteria, magazine advertisements for antiseptics and disinfectants, autoclave (optional).

**MOTIVATION:** "Since we cannot live in a glass cage, how can we reduce the chances of becoming infected?" (reduce presence of causative agents)

### DEVELOPMENT

1. Show ads. Ask: "How effective are these in preventing infections?" Introduce and compare the terms antiseptic (retards bacterial growth) and disinfectant (destroys most bacteria). Give examples of each (antiseptics -- dilute iodine, hydrogen peroxide); (disinfectants -- Lysol™, carbolic acid, chlorine). Ask: "How can we test the effectiveness of these substances?" (Use petri dishes from previous lesson.)

   Explain that a disinfectant is an agent that is used to kill microorganisms present on nonliving things. Most disinfectants are poisonous and cannot be used on or in the human body. Some substances containing chlorine are used in small amounts to control bacterial growth in drinking water, swimming pools, and laundry.

   An antiseptic is an agent that inhibits the growth and development of mircroorganisms without necessarily destroying them. An antiseptic agent acts predominantly as an inhibitor of bacterial growth.

2. Distribute Laboratory Worksheet 4.8 and petri dishes. Demonstrate how to transfer bacteria to a sterile agar plate.

3. On the chalkboard, identify the coded materials (A2 = tincture of iodine, etc.). Students should copy this list in Procedure 5 of the laboratory worksheet.

4. Demonstrate the proper procedure for barely opening the petri dishes and adding the materials from the droppers without touching the colonies.

   Each area is to receive one drop of an antiseptic (coded A) and one drop of a disinfectant (coded B). You may want to use other antiseptics or disinfectants.

5. After collecting the petri dishes and returning them to the incubator for later use, ask: "What other methods do doctors and dentists use to kill bacteria?" (boiling, steam under pressure) Introduce the term sterilization. (You may want to exhibit an autoclave).

SUMMARY

1. "Why do doctors rub alcohol over your skin before giving an injection?"
2. "Why must petri dishes be sterile before we use them?"
3. "How can scientists identify different types of bacteria under the microscope?"

FOR FURTHER THOUGHT

1. "Why were the astronauts who returned from the moon isolated upon their return?"
2. Have students do a report on Ignaz Semmelweiss and his contribution to medical science.

# LABORATORY WORKSHEET 4.8

NAME______________________________ CLASS______________ DATE______________

PROBLEM: How can we control the growth of bacteria in our environment?

INTRODUCTION: Up until the mid-1800s, many surgical patients died, not of their original illness, but due to blood poisoning. Dr. Joseph Lister found that when antiseptics were used during operations, many more people lived. Today you will see why Dr. Lister was honored for his work in sterile surgery.

MATERIALS: Two petri dishes with colonies, dropper bottles of: common mouthwash ($A_1$), tinture of iodine ($A_2$), hydrogen peroxide ($A_3$), Lysol ($B_1$), adhesive tape, marking pencil.

PROCEDURE

1. Obtain the two petri dishes you used in Laboratory Worksheet 4.7. Using a sterile transfer loop, transfer bacteria to a fresh, sterile agar plate by streaking.
2. Soak discs of filter paper (approximately 2 cm in diameter) in solutions of antiseptics, disinfectants, and mouthwashes.
3. Using sterile forceps, place several prepared discs on a streaked portion of the petri dish. Use a glass marker to indicate on the bottom of the dish the contents of each disc.
4. Record the codes of the materials you added.
5. Tape your petri dish and return it to your teacher for incubation.
6. Copy the codes of the antiseptics and disinfectants you used:

________________ ________________ ________________

________________ ________________ ________________

7. Incubate plates for 24 hours. Examine, record and interpret results.

SUMMARY/HOMEWORK

1. Why would you expect the Lysol$^{TM}$ to be the most effective of all the materials added?
2. Why is the name "colonies" a good name for the growths in the petri dishes?
3. Why shouldn't you be surprised if some petri dishes contain no colonies?

# Lesson 8: HOW DO BACTERIA AFFECT US?

PERFORMANCE OBJECTIVES: The students will be able to:

- state and describe the stages of a bacterial infection.
- graph the growth and reproduction of bacteria over a period of time.

MATERIALS: Laboratory Worksheet 4.9, petri dishes previously exposed to air.

MOTIVATION: "Why do bacteria have such a bad reputation?"

DEVELOPMENT

1. Explain the time lapse between exposure to a disease and the onset of symptoms. Distribute Laboratory Worksheet 4.9 to students and have them plot the growth of a bacterium which is undergoing fission every 30 minutes. [Some graph points may not fall on a line.] Then have students answer the questions that follow the graph.

   Discuss graph construction and note that the last point is off the graph.

2. Tell students that the first stage of bacterial growth is called incubation. Ask: "Why don't any symptoms normally appear during this stage?"

3. During the second, or illness stage, body functions are disturbed because the toxin (poisonous chemical substance) production by bacteria begins to produce initial symptoms normally associated with most bacterial infections (headache, fatigue, diarrhea, rash, nausea). Ask: "Why are doctors often unable to diagnose a disease at this point?" (As the disease progresses, specific symptoms appear.) Ask: "Why does the severity of symptoms vary among people?" Compare symptoms of disease to an iceberg, in that 75% of an iceberg is beneath the surface -- undetectable. An example of a disease which masks its symptoms is walking pneumonia.

4. Tell students that stage three is called convalescence. Ask: "Why can the length of this stage vary?" (general condition, etc.) Have students write a paragraph suggesting methods to help speed this period. Have some answers read aloud and list suggestions on chalkboard.

SUMMARY

1. "Why do the three stages of disease vary among people?"

2. "If bacteria are only microscopic in size, how can they make us sick?"

FOR FURTHER THOUGHT

- "Why is the illness stage of a disease usually the most contagious?"

# LABORATORY WORKSHEET 4.9

NAME________________________ CLASS________________ DATE____________

Bacteria reproduce by a process called fission, which means splitting. Complete the data table below. (You will need to know that it refers to a single bacterium which is undergoing fission into two parts every thirty minutes.) After you have completed the data table, plot the results on the graph below and connect all the dots with a single line.

## THE GROWTH OF A BACTERIUM

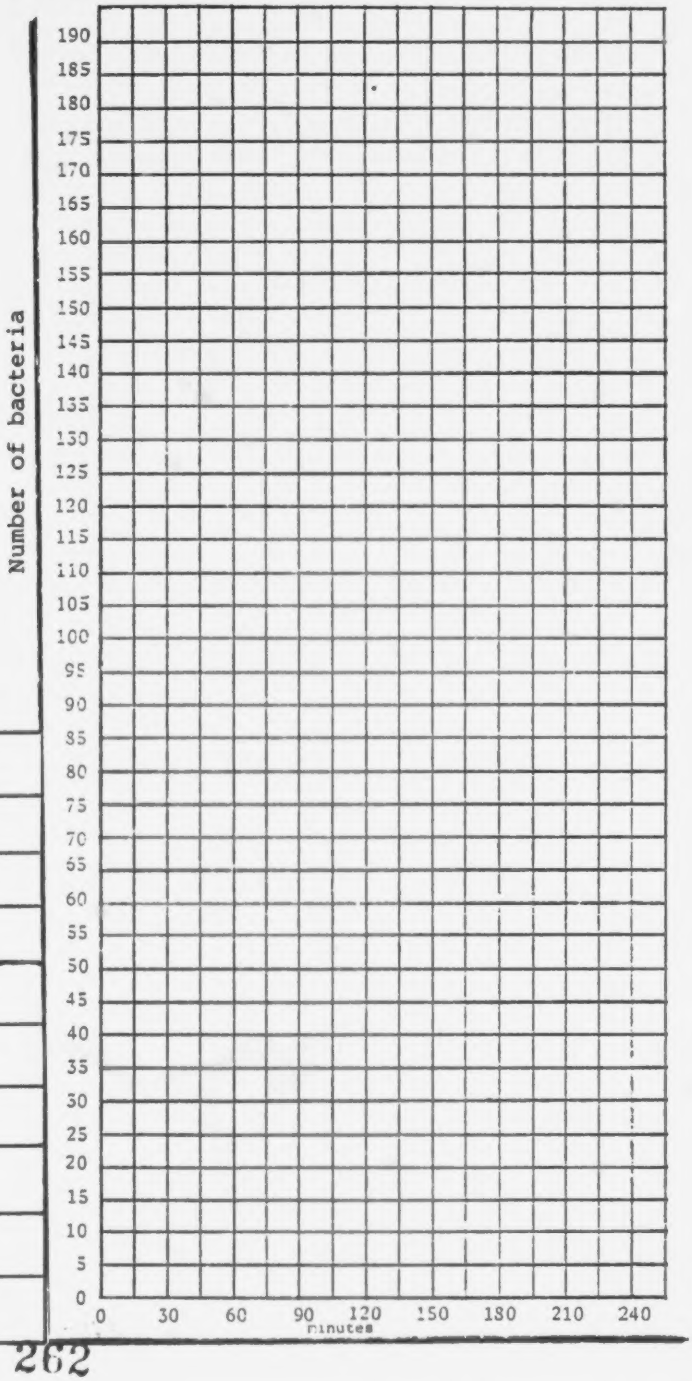
**NOTE: Some graph points may not fall on a line.**

How many bacteria are there after

1 hour?__________

2 hours?__________

6 hours? __________



DATA TABLE

| Time in minutes | Number of bacteria |
|---|---|
| 0 | 1 |
| 30 | 2 |
| 60 | |
| 90 | |
| 120 | |
| 150 | |
| 180 | |
| 210 | |
| 240 | |

## Lesson 9: WHAT ARE OUR DEFENSES AGAINST DISEASE?

**PERFORMANCE OBJECTIVES:** The students will be able to:

- describe the body's three main lines of defense.
- compare and contrast the roles of each segment of the body's defense mechanism.

**MATERIALS:** Charts of skin, respiratory system, digestive system, eye, ear, and blood cells; balloon; demonstration microscopes (or projection microviewer); slides of white blood cells.

**MOTIVATION:** "Why aren't we always sick?"

**DEVELOPMENT**

1. Introduce the body's first line of defense.

   a. Discuss structures (skin, mucous membranes, etc.) of the first line of defense. Use charts and models to illustrate the digestive tract, respiratory tract, etc. The first line of defense guards the surfaces of the body. The skin acts as a wall to keep bacteria out. Bacteria that enter the nose and mouth encounter the mucous membrane. The cells of these membranes manufacture mucous which traps large numbers of microbes. The cells of parts of the respiratory system are lined with cilia that are in constant motion. These cilia sweep the mucous and the bacteria trapped in it upward to the nose and mouth. In this way, large numbers of bacteria are removed from the respiratory system.

   b. Ask: "Why are tears considered a natural defense against bacteria?" Tears contain an enzyme that can destroy many of the bacteria that enter the eye.

   c. Ask: "As a bacterium, why would you face destruction once you reached the stomach?" (Develop the presence of $HCl$ and other digestive juices in the stomach.) Hydrochloric acid kills bacteria we swallow.

2. Introduce the body's second line of defense.

   - Show a blood cell chart stressing white blood cells. Using a partially inflated balloon, demonstrate and describe phagocytosis and pus formation. Ask: "Why does a doctor do a blood count?" (Evidence of an increase in white blood cells would indicate an infection.) The bacteria are swallowed up and destroyed by the white blood cells.

3. Introduce the body's third line of defense.

   - Ask: "How is your body able to defend itself against harmful microorganisms which have not been destroyed by the first two lines of defense?" Introduce the body's third line of defense, antibodies. Discuss their specific action of neutralization of toxins.

## SUMMARY

1. "Why are we not always sick?"

2. "Why is pus considered a symptom of infection?"

## FOR FURTHER THOUGHT

1. "Why do most newborn babies rarely get measles or mumps even though they make no antibodies?"

2. "What conditions can increase a person's susceptibility to harmful microorganisms?" (starvation, cold, alcoholism, etc.)

3. "Why do most people get childhood diseases such as measles and chicken pox only once?"

## Lesson 10: HOW CAN WE HELP OUR NATURAL DEFENSES?

PERFORMANCE OBJECTIVES: The students will be able to:

- distinguish between natural, active, and passive immunities.
- detail how people can acquire various immunities.

MATERIALS: A dictionary.

MOTIVATION: "Why must all students in NYC schools be immunized?"

DEVELOPMENT

1. Introduce and define immunity (ability to resist disease). Ask: "Why are babies immune to certain diseases for their first two months?" (antibodies from mother's blood). Ask: "Why is this called passive immunity?" Explain that passive immunity results in temporary protection. Cite other examples of temporary prevention or cure after infection (such as antitoxin obtained from immunized horses which is used for diptheria; and gamma globulin, a substance which is found in a person's blood after one recovers from a disease such as measles).

2. Tell the story of Edward Jenner (the father of vaccination) and his work with smallpox in the 1790s. (He observed that milkmaids who got cowpox infections never seemed to get smallpox, while thousands of people in other occupations were dying of it. He hypothesized that if he could expose people to cowpox, he could protect them from smallpox.) Ask: "Why were these people passively protected from getting smallpox?" Compare this with active immunity (in which a person develops antibodies or antitoxin in response to a mild stimulus such as a chicken pox infection). Have students list other diseases that can be prevented by vaccination -- measles, polio, etc. Salk and Sabin are names students should know in connection with polio vaccine. Ask: "How do we usually acquire active immunity?" (recovery from communicable diseases)

3. Ask: "Have you ever heard of a cow getting measles?" and "Have you ever heard of a woman or man getting hoof and mouth disease?" Species are naturally immune (from birth) to certain diseases. Ask: "Why are some people naturally immune to certain diseases like TB?"

SUMMARY

1. "Why are vaccines that produce passive immunity used in cases of disease epidemic?"

2. "Why is immunization before entering school considered so important?"

FOR FURTHER THOUGHT

1. "Why does a person rarely get measles a second time?"

2. "Why do we all have active immunity against cowpox but passive immunity against smallpox?"

## Lesson 11: HOW CAN DOCTORS HELP US WHEN WE ARE ILL?

PERFORMANCE OBJECTIVES: The students will be able to:

- relate sequentially Koch's postulates and their relevance to the diagnosis of disease.
- describe the role of antibiotics in diseases.
- show that some folk medicines have value.

MATERIALS: Two petri dishes with colonies (from previous work), penicillin discs (commercial or made by dissolving a penicillin tablet in water, then soaking filter paper in mixture).

MOTIVATION: "If you had a high fever, would you...

1. "put some salt on your tongue for ten minutes and then drink a glass of cold water?
2. "put a slice of raw potato on your forehead, held in place by a cloth bandage?
3. "drink tea twice a day made from the bark of a willow tree?"

(Explain that all these are examples of folk medicine.)

DEVELOPMENT

1. Ask: "How are doctors able to identify the causes of disease?" Introduce Robert Koch and his work in the late 1800s using the T.B. bacillus that led to the four steps (postulates) that prove a microbe guilty of causing an infectious disease:

   Step 1. The suspected microbe is present in every case where the disease is present.
   Step 2. The microbe can be removed and grown in pure culture.
   Step 3. If the microbe is injected into a healthy experimental organism, it then develops symptoms of disease.
   Step 4. When the microbe is removed from the experimental organism, it is found to be identical to that in Step 1.

2. Introduce antibiotics as biological chemicals derived from molds or other soil organisms which can retard the growth of some pathogens. Tell about Alexander Fleming who, in 1928, found his cultures being destroyed by a greenish mold. Ask class for examples of antibiotics (penicillin, tetracycline). Describe their action (interfere with some phase of bacteria's life cycle). Ask: "Why are some bacteria now resistant to the antibiotics that once killed them?" Recently, there has been a relaxation of the prohibition of the use of penicillin and tetracycline in barn animals.

3. Use two petri dishes with actively growing colonies (from previous investigation). Drop a penicillin disc into one. Ask: "How will we know if the penicillin affects the bacteria?" "Why are we using two petri dishes?" Incubate dishes for later observations.

4. Tell of people putting moldy bread on wounds. (It can contain penicillin mold.)

SUMMARY

- Refer to motivation and ask: "Why are some folk medicines of value?" (Willow bark contains salicylic acid, main ingredient of aspirin.)

FOR FURTHER THOUGHT

1. Have students research the continuing worldwide search for new antibiotics.

2. "Why are some bacteria now resistant to antibiotics that once would have killed them?"

3. "Why should antibiotics be discarded from a medicine chest after one year?"

# Lesson 12: WHY ARE VIRAL DISEASES BIGGER KILLERS THAN BACTERIAL DISEASES?

PERFORMANCE OBJECTIVES: The students will be able to:

- describe the reproduction of viruses in living things.
- associate viral needs to living cells.
- list some characteristics of viruses.

MATERIALS: Pictures of viruses (prepared by the teacher).

MOTIVATION: "The worst epidemic of modern times took place between April and November of 1918. Ten million people died, more than twice the number of deaths due to World War I. What could have caused such destruction?" (influenza)

DEVELOPMENT

1. Tell the class that in 1892 a Russian biologist, Dmitri Iwanowski, was studying tobacco mosaic, a condition which causes tobacco leaves to wrinkle. He extracted a juice from infected plants and rubbed it on healthy plants. These plants developed the mosaic disease. He then heated the juice to near boiling temperature and rubbed it on a healthy plant. No mosaic disease developed.

   Ask:

   - "Using the scientific method as a basis, what questions occur to you regarding Iwanowski's discovery?"
   - "Can you suggest a hypothesis?"

2. When scientists tried to grow viruses on agar, they were successful.

   Ask:

   - "How do viruses compare to bacteria?" (Viruses don't have "machinery" to convert raw materials into needed substances.)
   - "Why can viruses only function and reproduce in a living cell?" (A virus uses a cell's own parts to make more viruses.)
   - "Why can viruses be grown on fertilized chicken eggs or in tissue cultures?"

3. Ask: "What is a virus?"

   A virus is a small particle composed of DNA (sometimes RNA) and proteins. Viruses have the ability to reproduce provided they can use the machinery of a cell host. Each virus is composed of a number of building blocks. These building blocks are proteins synthesized in a host cell whose own DNA has been broken down by the virus which substitutes its own DNA for that of the host.

A virus is too small to be seen with ordinary microscopes. To be seen, viruses must be magnified tens -- or even hundreds -- of thousands of times. Such magnification is only possible with an electron microscope.

4. Ask: "Why are antibiotics ineffective against viruses?" and "Why doesn't a viral infection always kill us?" (Our bodies produce a viral fighter, interferon.)
5. Vaccines have been developed against some viral diseases. These include smallpox, measles, German measles, polio, some influenzas, and mumps.

SUMMARY

1. "Why is it usually easier to cure a bacterial disease than a viral disease?"
2. "Why is the start of most viral diseases more severe than bacterial diseases?"
3. "Why can viruses be seen only under an electron microscope?"

FOR FURTHER THOUGHT

1. "Why are people who recover from the Asian flu not immune to the Hong Kong flu?"
2. "Why is hepatitis (a viral disease) common among drug addicts?"

# Lesson 13: WHY DO YOU STAND A BETTER CHANCE OF GETTING SICK OUTSIDE THE USA?

PERFORMANCE OBJECTIVES: The students will be able to:

- relate environmental and medical factors to the incidence of disease.
- list and discuss some common bacterial infections.

MATERIALS: Chart of types of bacteria.

MOTIVATION: "Why must you present proof of vaccination when applying for a passport to visit Africa or India?"

## DEVELOPMENT

1. Refer to charts on causes of death (Unit 2) and review 1900 vs 1980 to show decline in deaths due to diseases, including bacterial diseases. Tell about the most severe epidemic in recorded history -- bubonic plague -- carried by rats from India to Europe between 1347 and 1351 and killing an estimated 75 million people (more than 1/4 of Europe's population). Ask: "Why can't an epidemic of these proportions occur today?" (diagnosis [Koch's postulates], treatment [antibiotics], prevention [vaccines])

2. Ask: "Why have no cases of cholera (an acute intestinal disease) been reported in the U.S. since 1911, yet it still occurs in India?" Develop concept that possibility of contracting bacterial diseases can be lessened by proper diet, rest, exercise, and proper sanitation.

3. Discuss a bacterial infection or outbreak recently in the news.

## SUMMARY

1. Ask: "Has anyone in the class ever had diptheria, tetanus, or whooping cough?" "Why not?" (DTP vaccine in infancy.)

2. Why do schools require a DTP booster upon entry?"

## FOR FURTHER THOUGHT

- Student reports can be done on bacterial diseases that at one time were, but no longer are, widespread in the United States. The reports should explain how these diseases were controlled.

## Lesson 14: WHAT ARE SOME OTHER INFECTIOUS DISEASES THAT PEOPLE CAN GET?

PERFORMANCE OBJECTIVES: The students will be able to:

. list diseases caused by fungi, worms, protozoa, and rickettsias.
. relate incidence of these diseases to geography.

MATERIALS: Charts showing fungi, protozoa, worms.

MOTIVATION: "In 1880, France sent an army of men to Panama and after a short period of time, 16,000 had died. What war was this?" (It was not the result of war, but the attempt to build a canal. Malaria was the culprit.)

DEVELOPMENT

1. Explain that malaria is a chronic cyclical disease caused by a protozoan carried in the salivary glands of the female anopheles mosquito. Ask: "Why is malaria most prevalent in tropical countries?" (more breeding grounds) "How can these breeding grounds be destroyed?" (drain swamps, insecticides, oil on water's surface to suffocate larvae)

2. Tell students that rickettsias are microorganisms, intermediate in size between bacteria and viruses, which can only survive in a living cell. Rickettsial diseases are transmitted by vectors (a vector is an agent, usually an insect or other animal, able to carry pathogens from one host to another) like ticks (transmitting Rocky Mountain Spotted Fever, Lyme disease) and lice (transmitting typhus). Such vectors are abundant in certain areas. In many states hikers should be cautious in wooded areas.

3. Inform the class that the largest parasites to infest humans are worms. Eggs and/or larvae can enter our bodies either in food or through the skin. Examples are trichina, tapeworm, and flukes (from raw fish).

4. Develop concept that disease-causing organisms can be carried by different intermediaries with which we can (and do) come in contact. (Example: mosquitoes, ticks, lice, etc.)

5. Ask: "Why shouldn't New Yorkers drink the local water when visiting Mexico?" (amoebic dysentery)

6. Explain that fungal diseases are more common to us. Ringworm and athlete's foot are examples.

SUMMARY

1. "Why are modern hygienic practices and methods of waste disposal the best preventive measures to follow in order to avoid getting most of the diseases discussed today?"

2. "Why should a traveler be cautious about drinking the local water in a foreign country?"

3. "Why should a person be cautious about eating undercooked pork?"

FOR FURTHER THOUGHT

1. "The United States was able to build the Panama Canal. It was started in 1905, just 25 years after the French tried. What did we know that the French didn't?"

2. "Why isn't immunization the only answer in preventing disease?"

## Lesson 15: WHERE CAN WE GO FOR HELP IN HEALTH RELATED MATTERS?
[Optional]

PERFORMANCE OBJECTIVES: The students will be able to:

- discover the locations of significant community health agencies and their functions.
- produce a student health directory of agencies located in the community.
- if desired, publish the directory for school distribution.

MATERIALS: Phone book (white pages), several copies.

MOTIVATION: "If a friend told you that he or she may have a venereal disease (or that he or she simply feels unwanted), where would you suggest he or she turn for help in each case?"

DEVELOPMENT

1. Using the question in the Motivation as a basis, have students pose similar questions on problems that can or do face them.

2. From the questions raised in Step One above, develop a list of possible sources of help as follows:

pregnancy counselor
mental health clinic
hospital
psychiatric social worker
Alcoholics Anonymous
ambulance service
school counselor
health department
rape counselor
veterans administration
family/child guidance clinic

3. Using several phone books, have students locate some of the above sources of help provided by the United States government, the state, and the city.

4. On the chalkboard, begin a map of the area surrounding your school, using large avenues and streets as boundaries. (This might have to be enlarged to include state and government facilities.)

5. For homework, have students finish the map.

6. You might want to invite community health resource personnel to class to explain and demonstrate what they do.

SUMMARY

- "In order for a community hospital to be considered a 'total hospital,' what services should it offer?"

FOR FURTHER THOUGHT

- Produce and publish a directory of community health agencies.

## Lesson 16: HOW DO SCIENTISTS IDENTIFY A NEW DISEASE?

PERFORMANCE OBJECTIVES: The students will be able to:

. define AIDS as a disease of the immune system.
. list the possible methods by which AIDS is transmitted.
. recognize some of the fears created by a new disease such as AIDS.
. explain how scientists go about trying to find cause of a new disease.

MATERIALS: Newspaper and magazine articles dealing with AIDS, herpes, toxic shock syndrome, Legionnaires' Disease, Lyme Disease, etc.

MOTIVATION: "After four decades of medical victories, infectious agents are striking back with new intensity in the war between human beings and contagious diseases. These infections include acquired immune deficiency syndrome (AIDS), herpes, toxic shock syndrome, Legionnaires' Disease. What problems does this pose to scientists?"

* **NOTE TO TEACHER:** This lesson will be developed for AIDS, but material will be included for herpes. The material can also be used to develop lessons for other diseases.

DEVELOPMENT

. Ask the students the following questions and go over the answers with the class.

1. "What is Acquired Immune Deficiency Syndrome or AIDS?"

   AIDS is a name given to a recently recognized medical condition. "Acquired" indicates that it is not inherited. "Immune Deficiency" is the factor common to all cases - An unexplained inability of the body to defend itself against infections. "Syndrome" refers to the variety of specific diseases which can occur; these are sometimes referred to as opportunistic infections as they take advantage of this loss of natural immunity against diseases.

2. "What are some of the specific diseases that affect AIDS patients?"

   Many AIDS victims have had one or both of two rare diseases: Kaposi's sarcoma, a type of cancer, and pneumocystis carinii pneumonia, a parasitic infection of the lungs. In addition, severe life threatening bacterial yeast or viral infections can occur.

3. "Who seems to be affected by this disease?"

Currently men make up the large majority of all reported cases. Cases have been identified in male and female intravenous drug users, a small number of Haitians residing in the United States and a few individuals with hemophilia. Approximately 5% of all cases do not belong to any of these recognized groups. About 95% are males in the age range of 25-44 years. All races have been affected.

4. "What do scientists believe may cause AIDS?"

Investigators have not been able to find the cause or causes of this loss of immunity. The pattern of occurrences among the diverse group suggests that an infectious agent or agents may, in part, be the cause of AIDS, but this has not been proven. Other contributing factors are being investigated.

5. "How is AIDS transmitted?"

Although a cause for the syndrome has not been found, it appears that intimate, direct contact, such as sexual contact or injection into the blood, is required. There is no evidence that AIDS is spread through the air or by other forms of casual contact that commonly occur in the workplace or school.

6. "What are the symptoms of AIDS?"

There are no clear cut symptoms, but many patients with AIDS have had enlarged lymph nodes (swollen glands) at several different sites in the body. Some have had unexplained diarrhea accompanied by a significant weight loss. These symptoms can occur over a period of months before a specific disease such as Kaposi's sarcoma or pneumocystis pneumonia is diagnosed.

7. "How is AIDS diagnosed in the laboratory?"

There is no specific test for diagnosing AIDS. The immune defect in AIDS has not been identified, but many patients show a decrease in the number and function of certain white blood cells called T-helper lymphocytes. Although the function of these cells can be measured, these tests are not sensitive or specific enough to be used routinely and are not generally available.

8. "What is being done about AIDS?"

Government and other medical research groups are giving high priority to investigation of both the causes and the methods for control and prevention. Physicians, public health advisors, epidemiologists, statisticians, laboratory scientists and others are working across the country.

In New York City the Department of Health keeps count of all cases in the city to study disease trends. In November 1982 an active surveillance program was begun to seek out hospitalized cases of AIDS. The department of health sponsors a monthly meeting attended by clinical researchers at which current ideas and studies of AIDS are discussed.

## SUMMARY

1. "How is AIDS similar to diseases such as Legionnaires' disease?"
2. "How are the scientists studying AIDS similar to great scientists of the past like Louis Pasteur and Edward Jenner?"

# AN IMPORTANT MESSAGE TO ALL BLOOD DONORS

## WHAT IS AIDS?

AIDS or Acquired Immune Deficiency Syndrome is a condition in which the body's normal defense mechanisms against certain diseases or conditions are reduced. As a result, patients often develop unusual infections such as Pneumocystis pneumonia or a rare form of skin cancer, Kaposi's sarcoma. There is no known cause, preventative measure, laboratory test, or treatment for AIDS.

## WHO IS AT RISK?

It is known, however, that certain groups are at a high risk of contracting the disease. These include:

- those with symptoms and signs suggestive of AIDS;
- sexual partners of individuals at increased risk of AIDS.
- sexually active homosexual or bisexual men with multiple partners;
- Haitian entrants to the United States;
- present or past abusers of intravenous drugs;
- patients with hemophilia; and

## WHAT DOES AIDS HAVE TO DO WITH GIVING BLOOD?

While extensive research is still ongoing and no final conclusions have been reached regarding the cause of AIDS and its transmission, there is a suggestion that occasionally the disease may have been spread through the transfusion of blood products. Because of this suggestion, this Blood Center is asking that you voluntarily refrain from donating at this time if you are in any of the currently identified high risk groups. Although the majority of members of these groups are not carriers, there is presently no means of detection and thus no mechanism to identify those few who may be at risk.

We appreciate the time and effort involved in making a trip to the blood bank, and hope that all donors will recognize the necessity of the voluntary screening procedures which have been instituted as a temporary precaution.

The blood donor's signature on the Center's registration card indicates that the donor has read and understands the above information.

Additional information concerning AIDS is available from the Charge Nurse.

North Jersey Blood Center
East Orange, N.J. 07018

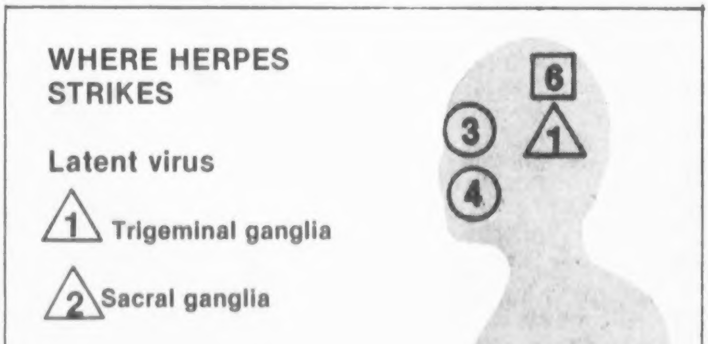
Developed with the American Association of Blood Banks in response to Public Health Service recommendations.

# BATTLING AN ELUSIVE INVADER

The Herpes Virus Perplexes Researchers and Defies a Cure

By any measure, herpes is an extraordinary bug. "It is the ultimate parasite," declares University of Michigan microbiologist Charles Shipman. Says Washington, D.C. urologist Peter Gross: "If you were doing a science-fiction movie, you couldn't invent something better than herpes." What makes it unique is that unlike influenza and other viruses, it survives in the human body long after an attack has subsided. "Once herpes has found its way into your system," says Dr. Harold Kessler, a Chicago specialist in infectious disease, "it's your virus for life."

This perplexing persistence is characteristic of all five members of the human herpes family. After herpes simplex 1 and 2, the best known is the varicella-zoster virus, the cause of chicken pox, the nation's third most common ailment. Three-quarters of the U.S. population gets chicken pox by age 15. Most are never bothered by the virus again, though it will linger in their nervous systems for the rest of their lives. Some will not be so lucky. They will be victims of shingles, a painful, blistering rash that is triggered in adults when, for reasons unknown, the varicella-zoster virus reawakens.



TIME Charts by Renee Klein

Cytomegalovirus (CMV), another type of herpes, infects up to 80% of the U.S. population, and nearly 100% of male homosexuals. Though not usually a problem for adults, CMV can be deadly to cancer patients and others whose immune systems have been suppressed by drugs. It also causes a wide range of birth defects and is the most common cause of infectious retardation in infants. Epstein-Barr virus is the herpes associated with mononucleosis. More tragically, it is believed to contribute to Burkitt's lymphoma, a cancer that mainly strikes Africans.

Herpes simplex is almost always transmitted by intimate contact between infected and noninfected skin surfaces. This does not necessarily mean sex. Notes Kessler: "If a mother has a cold sore, she shouldn't be kissing her children or anyone else." Once inside, herpes reproduces by taking over the protein-producing apparatus of the host cell. Gross calls it "a biological coup d'etat."

Once the attack has been brought under control by the immunological system, the virus retreats. In oral herpes, which is generally caused by herpes simplex Type 1, it travels through nerve fibers into the trigeminal ganglea, a group of nerve cells located near the brain. In genital herpes, usually caused by Type 2, the virus withdraws to the sacral ganglea, nerve cell clusters near the spinal cord. Lodged in the nerve cells, the herpes simplex virus is beyond the reach of the body's immune system and enters a latent stage. This stage may last forever, or it may be broken when the virus reawakens and reinfects the original site. Such recurrences may take place as often as twice a month or as rarely as once a decade.

On rare occassions, herpes in the trigeminal ganglia will journey to the brain, where it causes a generally fatal form of encephalitis. Or, in about 500,000 cases a year (including recurrences), it may follow the trigeminal nerve to the eye, provoking an infection that can seriously damage vision if left untreated. Similarly, Type 2 located in the sacral ganglia will sometimes travel to the spinal cord, producing a mild form of meningitis.

Genital herpes has also been associated with cancer of the cervix, though the evidence is inconclusive. Obscuring the issue is cervical cancer's linkage with such other factors as an early loss of virginity and a high number of sexual partners. Recently, researchers have found pieces of viral DNA in cervical tumor cells. Says microbiologist Fred Rapp of Pennsylvania's Hershey Medical Center: "This suggests that the link is more than just statistical."

How the latent virus awakens from its slumber remains the central enigma of herpes. Dr. Abner Notkins and others of the National Institutes of Health (NIH) believe that a chemical change may cause nerve cells where the virus lurks to become "permissive" to viral replication and hence to an attack. Whatever the internal mechanism, recurrences can be triggered by sunlight, sex, menstruation and stress.

When genital herpes recurs in the final weeks of pregnancy, strict medical precautions are necessary. Herpes is lethal to up to 60% of infected newborns. For surviving babies, there is a 50% risk of blindness or brain damage. Because neonatal herpes is generally acquired during passage through an infected birth canal, a caesarean is necessary if the mother has an active infection. Los Angeles obstetrician Lynn Yonekura, a specialist in high-risk births, recommends biweekly tests for the presence of the virus during the final trimester of pregnancy. If the tests are all negative, Yonekura believes that a vaginal delivery is safe.

The only proven treatment for genital herpes and the only one approved by the FDA is acyclovir, a creamy salve marketed by Burroughs Wellcome Co. under the trade name Zovirax. Acyclovir, which retails for about $20 a tube, works by interfering with viral replication. Applied during the intial episode of herpes, acyclovir will alleviate symptoms and speed up healing. Unfortunately, it is less effective in treating subsequent episodes and will not reduce the frequency of outbreaks.

*Time,* 2 August 1982.

# Lesson 17: WHAT ARE THE POLITICAL AND SOCIAL IMPLICATIONS OF A NEW DISEASE?

PERFORMANCE OBJECTIVES: The students will be able to:

- evaluate the national and international implications of disease.
- recognize the political and financial decisions that are needed for disease control.

* **NOTE TO TEACHER:** While this lesson is written about AIDS, the students should be able to apply the questions raised to other diseases.

MATERIALS: Newspaper and magazine articles

MOTIVATION: "Would you visit a friend who had AIDS?"
"Should funeral home employers be protected against AIDS?"
"What will happen if all people stop giving blood because of AIDS?"

## DEVELOPMENT

1. Have students discuss AIDS from the point of view of the following:

   a. person who has the disease
   b. friend or relative of AIDS victim
   c. Mayor of New York City
   d. Governor of New York City
   e. President of the United States
   f. director of a funeral home
   g. Red Cross blood drive director
   h. prison guard
   i. hospital worker

2. Ask: "At what level of government should disease research be financed?" In the case of AIDS, about half the cases in this country come from New York State. Ask: "Does that give New York greater financial responsibility?" and "What role can the federal government play in disease control?"

3. Ask: "How can we get other countries to cooperate?" In the example of AIDS, there are areas in Africa and Haiti where AIDS appears. The French do not want to use American blood products becuase of the fear of AIDS.

## SUMMARY

- "Write a paragraph that discusses AIDS from one of the above viewpoints."

# Lesson 18: WHAT KINDS OF HEALTH RELATED CAREERS ARE AVAILABLE IN NEW YORK CITY?

PERFORMANCE OBJECTIVES: The students will be able to:

- develop an awareness of career opportunities in health care.
- list several occupations in the area of health occupations.

MATERIALS: List of health careers and a list of places to write for more information on health careers.

MOTIVATION: "How many students have working papers?" "What are the requirements to get working papers?" Elicit that a visit to the Board of Health is necessary in order to get working papers. Discuss other functions of the Board of Health. Mention the location of the Board of Health nearest the school.

## DEVELOPMENT

1. Project a street scene using a slide or an opaque projector (book) showing a street of stores including (as many as possible) a pharmacy, optician, a health food store, a medical and dental clinic, or the Board of Health. Ask: "How are these places directly involved with maintaining community health?"
2. Ask: "What jobs are associated with the pharmacy, clinic, Board of Health?" (Elicit: pharmacist, laboratory technician, X-ray technician) List the job titles and responsibilities on the chalkboard.
3. Ask: "How do these jobs relate to the treatment and/or prevention of diseases?" (Elicit: dispenses medication to cure disease; analyzes blood to ascertain nature of disease; X-rays bones and lungs so doctors can diagnose disease)
4. Distribute handout on health occupations and ask students to select a job title, other than a doctor or nurse, in which they are interested.
5. Have students research duties involved in the position, and courses needed to attain such a position.

## SUMMARY

1. "What are some of the professions that provide us with our basic health care?"
2. "Which health care professions are easily found in your neighborhood?" "In which health careers do people work 'behind the scenes'?"
3. "Which health care professionals specialize in the eyes?" "What is the title of the person who makes plastic eyes?" "How do you think these workers learn their profession?"

# Background Material for Teacher

## Partial List of Occupations, Duties, Qualifications, and Opportunities

| Position | Duties | Qualifications |
|---|---|---|
| Certified Lab Assistant<br>opportunities: increasing in rural areas, competitive | variety of routine tests: collecting blood specimens; examining blood, urine with microscope; work under a technologist or physician | H.S. diploma--science and math courses<br>1 yr. CLA School plus exam |
| Medical Lab Technician<br>opportunities: competitive | more complex than CLA | H.S., degree from Junior College plus lab experience |
| Medical Technologist<br>opportunities: good advancement | highly skilled tests; individual judgment in diagnosis and treatment of diseases | 3 yrs. college plus 1 yr. clinical ed. plus certification |
| Specialist Blood Bank Technology<br>opportunities: excellent; demand exceeds supply | routine and specialized tests with blood typing and analysis | Med. Tech. or BS in biological or physical science plus<br>1 yr. lab experience |
| Dietetic Assitant<br>opportunities: favorable | supervise services; assist menu planning; help patients with menus;<br>instruct and train workers | H.S. or equiv.; 1 yr. program in food management plus D.A. certificate |
| Pharmacist<br>opportunities: very good | compound and dispense medication; work closely with hospital staff | B.S., 5 yrs. college plus 1 yr. extra |
| Physical Therapy Assistant<br>opportunities: good | work under direction of phys. therapist; administer exercises, massage to people with stable conditions | H.S. plus 2 yrs. accredited Jr. or Comm. college |
| X-Ray Technologist<br>opportunities: mixed depending on area of country | take X-rays for use in diagnosis in hospital or clinic; on call any hour | H.S. courses in math and physics; 2 yrs. prof. education |

# Career Information

The following publications provide additional material on health careers. The source cited should be contacted regarding curent purchase price of the publication, if any. The Health Careers Counseling Serice of the UNITED HOSPITAL FUND OF NEW YORK would like to extend its thanks and appreciation to the organizations, agencies, and professional societies (denoted by an asterisk--*) for their kind permission in allowing us to excerpt and adapt material from their publications.

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* American Association of Colleges of Pharmacy, Career Opportunities in Pharmacy.
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American Association for Respiratory Therapy, Respiratory Therapy--A Career for Now and in the Future.
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Association of Physician Assistant Programs, The National Physician Assistant Program Profile 1975-76, 1st edition, Washington, D.C. 1974.
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*Educatinal Sound Film Strip Directory,* 8th edition, Dukane Corporation Audio Visual Material, St. Charles, IL 60174. Price: $Free

*Educator's Guide to Free Health, Physical Education and Recreation Material,* 7th edition, Edocator's Progress Service, Inc., Randolph, WI 53956, Price: $10

*Free Non Films,* Association-Sterling Films, 866 Third Avenue, New York, NY 10022, Price: Free

*Health Careers, a Directory of Career Information and Training for N.Y.S. 1975-76,* United Hospital Fund of New York

*Health Careers Film Guide,* United States Government Printing Office, Washington, D.C. 20402, Price: $0.35

*The New York Public Library,* Branches in each borough of New York City

# Counseling

Alumnae Advisory Center Inc.
541 Madison Avenue
NY 10022 (754-2153)
Counseling for women college
graduates (free to nonmembers)

Aspira Inc.
296 Fifth Avenue
NY 10001 (244-1110)
Educational and career
counseling (especially for
Puerto Rico)

Catalyst National Headquarters
6 East 82nd Street
NY 10028 (628-2200)
Employment services for women

Computer Based Educational
Opportunity Center
CUNY Office of Admission Service
875 Avenue of the Americas
NY 10001 (790-4653)
Open to the public; educational
and training information service

Equal Employment Opportunity
Commission
26 Federal Plaza, Suite 4000
NY 10007 (264-3640)
Assistance in employment
discrimination

Federation Employment and
Guidance Service
215 Park Avenue
NY 10010 (677-4600)
Job counseling and placement
for ex-offenders

Jobs For Youth
1801 Second Avenue
NY 10028 (247-3336)
Job counseling for men
and women 14-21

Just One Break, Inc.
373 Park Avenue South
NY 10016 (725-2500)
Placement services for
physically disabled

Manhood Foundation, Inc.
Central Administration
290 Lenox Avenue
NY 10027 (427-8800)

New York State Education
Department
Office of Vocational
Rehabilitation
255 Park Avenue South
NY 10003 (777-7010)
Placement, counseling and
education for disabled

New York State Employment
Service
370 Seventh Avenue
NY 10001 (563-7660)
Open to the public

Private Concerns
277 Madison Avenue
NY 10016 (644-1860)
Job training and placement
for ex-offenders

Project Find
160 West 71st Street
NY 10023 (874-0300)
Employment services
for the elderly

The University of the State of
New York
The State Education Department
Division of Professional
Licensing Service
99 Washington Avenue
Albany, NY 12210
Health careers licensure

Veteran's Health Manpower
2 World Trade Center
NY 10047 (488-6208)
Job counseling and placement
in health field

Vocational Foundation, Inc.
353 Park Avenue South
NY 10010 (889-1500)
Job counseling for men
and women 18-21

## Lesson 19: WHAT KINDS OF JOBS ARE NECESSARY FOR A HOSPITAL (MEDICAL CENTER) TO FUNCTION?

PERFORMANCE OBJECTIVES: The students will be able to:

- identify several occupations other than "doctor/surgeon/nurse" which are part of the basic hospital support team.
- list services offered by a major medical center or hospital.

MATERIALS: Organization tables of departments of a major medical center to duplicate and distribute to the class.

MOTIVATION: "Who has ever been a patient in a hospital?" "What conditions brought you to the hospital?" "What treatment did you receive?" "How many different people took care of you?" List student responses on the chalkboard. Try to list a variety of specialists, as well as technicians and other support personnel.

DEVELOPMENT

1. Ask: "What services does a hospital offer?" Discuss the fact that hospitals are in the center of the health care industry. They offer a wide variety of services: emergency rooms, out-patient clinics, operating rooms, research facilities.

2. Distribute the sample career ladder. Discuss the types of jobs listed and the education needed for employment.

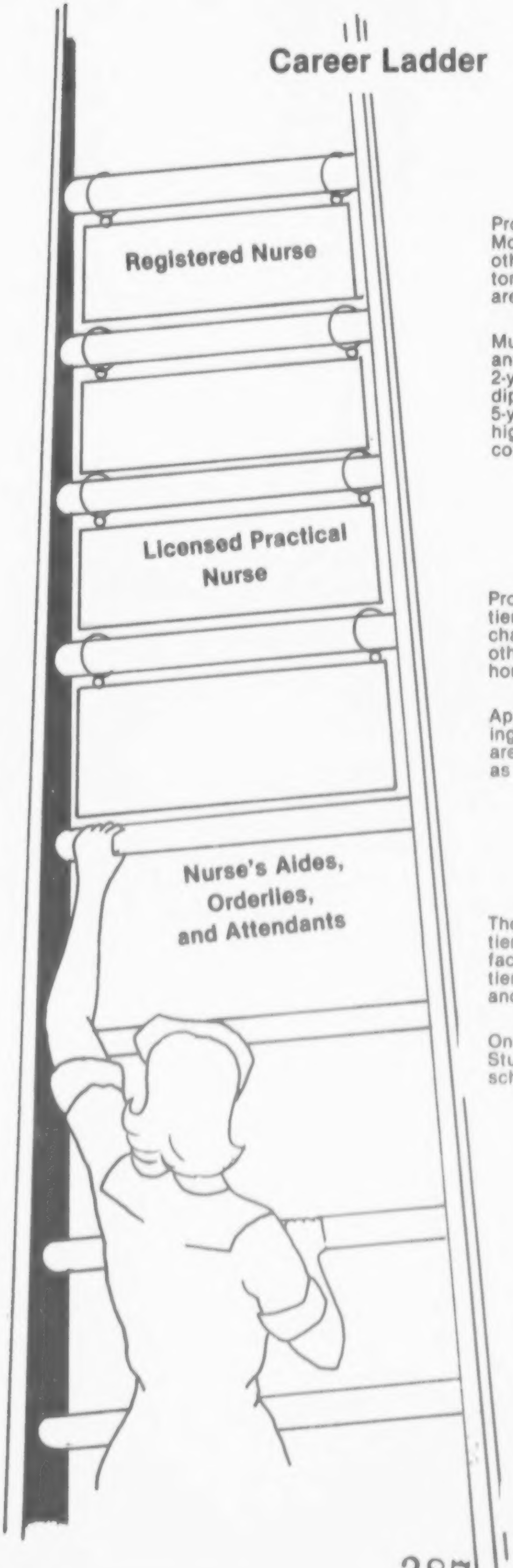
3. Ask: "What types of occupations make up the hospital support team?" (Elicit and list: X-ray technicians, paramedics, dieticians, physical therapists, lab technicians, social workers, and maintenance personnel are as important as the doctors and nurses.)

4. Ask students how they can climb the career ladder from entry level jobs to the next higher level. Discuss the importance of continuing their education in a rapidly changing technological society.

5. Distribute the three organization tables. Direct students to select one of the departments of the hospital and research the jobs listed on the charts.

6. Direct students to draw a career ladder for an occupation based on their research.

# Career Ladder



### Registered Nurse

Provide care for sick and help healthy people stay well. Most nurses work in hospitals, nursing homes, and other institutional health facilities. Others work in doctors' offices, do private duty, teach, do research and/or are staff members of professional organizations.

**Education**

Must be a graduate of an approved school of nursing and pass a State exam. Training programs include 2-year associate degrees in a community college; 3-year diplomas in hospitals and independent schools; 4- or 5-year bachelor's degree programs in college. Interested high school students should take as many science courses as possible. A license is required.

### Licensed Practical Nurse

Provide much of the bedside care needed by hospital patients. LPNs take temperature and blood pressure, change dressings, bathe patients and perform many other nursing functions. Most work in hospitals, nursing homes, clinics, and doctors' education offices.

**Education**

Applicants must complete an approved practical nursing course and pass an exam. High school graduates are preferred. Students who are interested should take as many science courses as possible.

### Nurse's Aides, Orderlies and Attendants

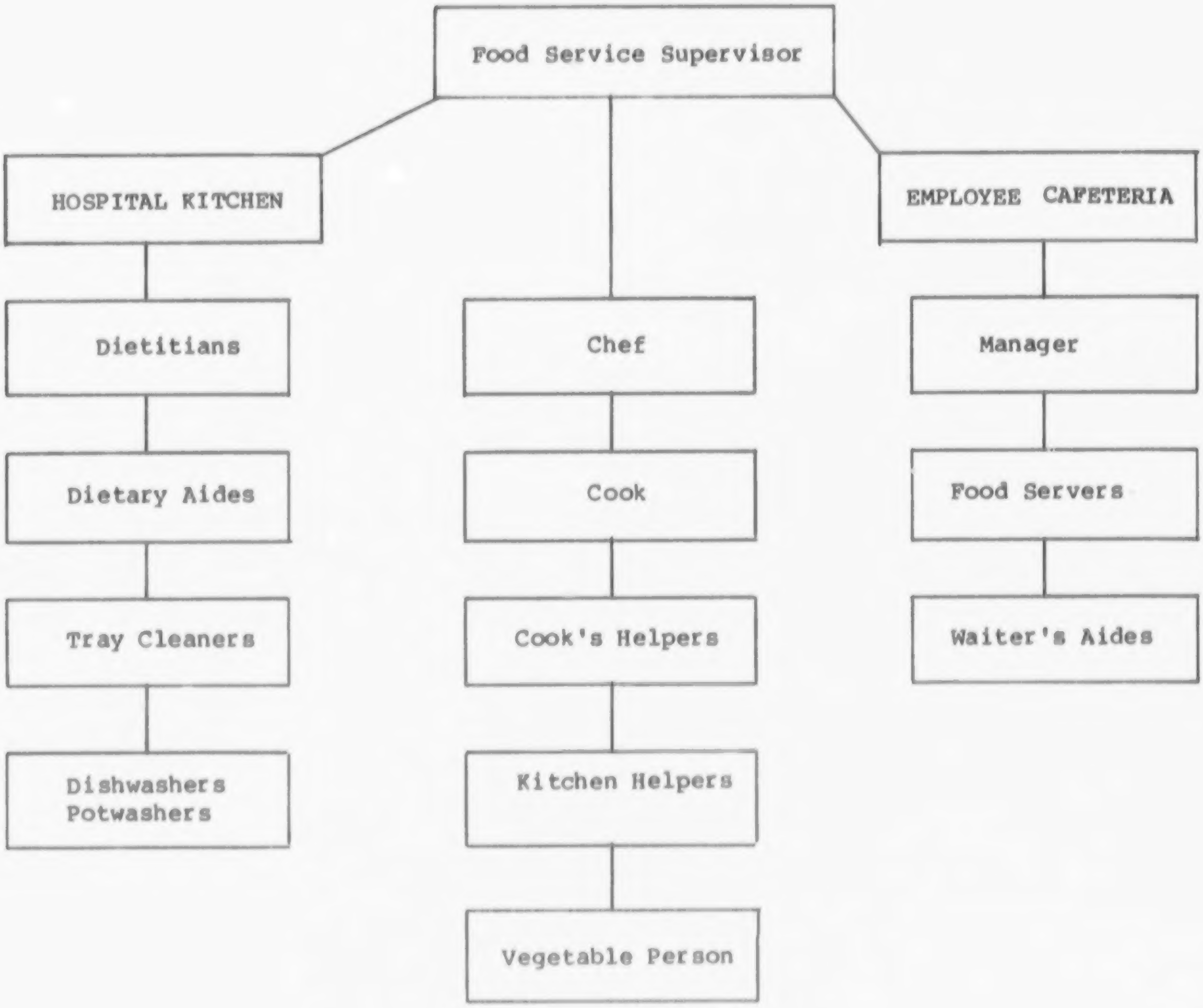
These workers handle many of the routine aspects of patient care in hospitals, nursing homes, and other health facilities. They answer patients' bell calls, assist patients in walking, transport and set up heavy equipment, and clean patients' rooms.

**Education**

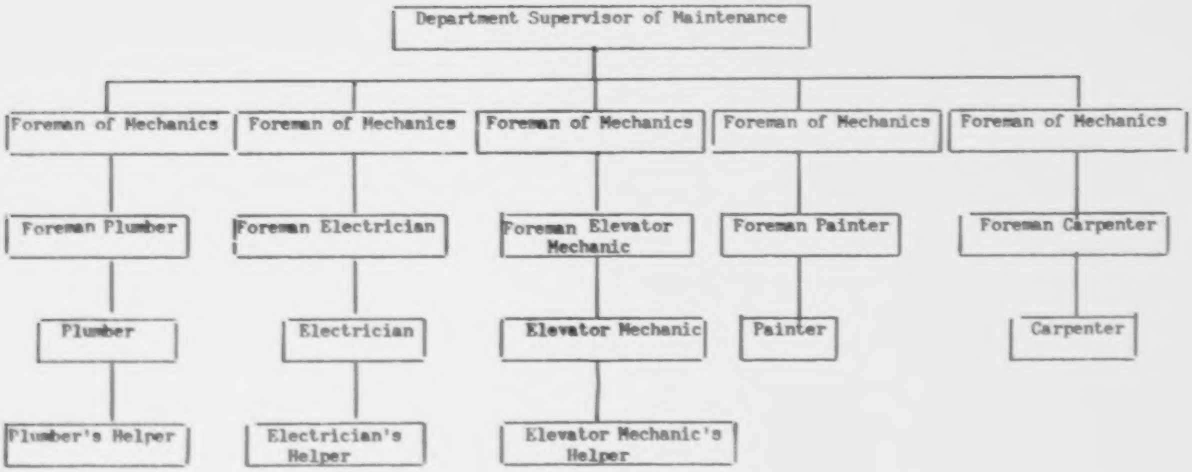
On-the-job training from several days to a few months. Students interested should volunteer while in high school.

Adapted from *Exploring Careers*, U.S. Department of Labor, Bureau of Labor Statistics, 1979.

## Dietary Department


Food Service Supervisor
HOSPITAL KITCHEN
EMPLOYEE CAFETERIA
Dietitians
Chef
Manager
Dietary Aides
Cook
Food Servers
Tray Cleaners
Cook's Helpers
Waiter's Aides
Dishwashers
Potwashers
Kitchen Helpers
Vegetable Person

# The Maintenance Department


Department Supervisor of Maintenance
Foreman of Mechanics
Foreman of Mechanics
Foreman of Mechanics
Foreman of Mechanics
Foreman of Mechanics
Foreman Plumber
Foreman Electrician
Foreman Elevator Mechanic
Foreman Painter
Foreman Carpenter
Plumber
Electrician
Elevator Mechanic
Painter
Carpenter
Plumber's Helper
Electrician's Helper
Elevator Mechanic's Helper

## Questions for Review

NAME__________________________________CLASS____________DATE____________

DIRECTIONS: For each of the numbered blanks in the cloze passage on the left, select the lettered term from the column on the right which best completes the sentence.

A group of students was assigned the job of collecting bacteria from different parts of their classroom. They were then to grow these ___1___ on the jelly-like material in their ___2___ dishes.

Bacteria are microscopic in size, but after the students had ___3___ their dishes for several days, the bacteria had reproduced many times by ___4___ until they had formed ___5___ which the students were able to see with their unaided eyes.

The students made sure that the bacteria they observed were the ones they had collected and not bacteria which had already been present on the jelly by using dishes which had been ___6___ before they were opened and used.

1. A. microscopic animals
   B. viruses
   C. microorganisms
   D. antigens

2. A. Erlenmeyer
   B. Bunsen
   C. condensing
   D. petri

3. A. incubated
   B. sterilized
   C. fixated
   D. cultivated

4. A. budding
   B. fission
   C. conjugation
   D. regeneration

5. A. satellite groupings
   B. islands
   C. colonies
   D. massed strands

6. A. purified
   B. pasteurized
   C. condensed
   D. sterilized

NAME________________________________________

DIRECTIONS: Match the disease from the list below to the statement below which best describes that disease. An answer may be used more than once or not at all.

A. pneumonia
B. cancer
C. heart disease
D. all of these
E. none of these

7. _____ The major cause of death in the United States today

8. _____ The major cause of death in the United States in 1900

9. _____ Infectious disease

10. _____ Has been conquered by modern medicines and medical techniques

11. _____ Evidence of the disease can be detected using a sphygmomanometer and an E.K.G.

12. _____ Abnormal reproduction of cells may produce a lump or tumor

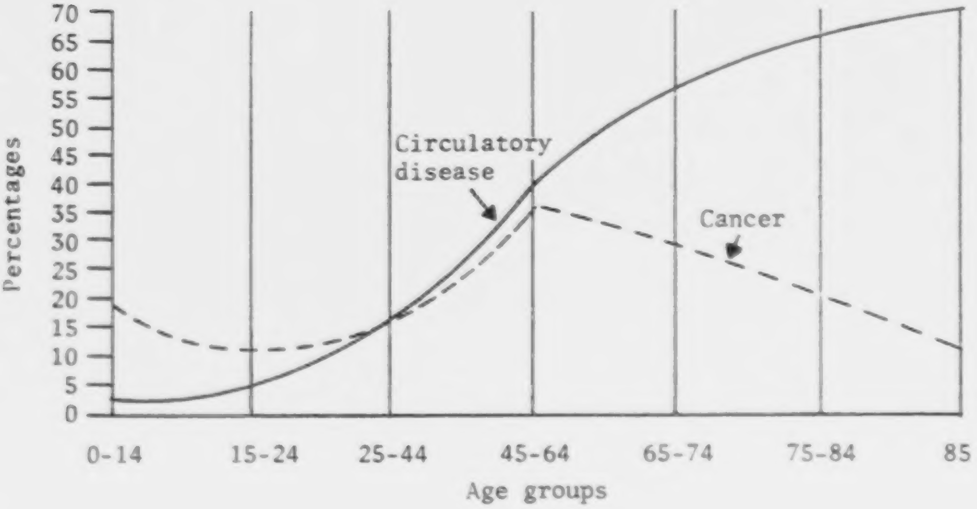
13. _____ Can be cured with special diets

14. _____ Which one of the following individuals (A, B, C, or D in the chart below) is most likely to develop heart disease this year?

| Individual | A | B | C | D |
|---|---|---|---|---|
| Sex | Male | Female | Male | Female |
| Age | 16 | 35 | 55 | 60 |
| Blood pressure | high | high | high | average |
| Personality | "up-tight" | "up-tight" | "up-tight" | relaxed |
| Cigarettes | 2 pack/day | 1 pack/day | 1 pack/day | none |
| Diet includes | junk food | low fat | high salt | high fat |

NAME_______________________________________

DIRECTIONS: The graph below compares the ages at which people die due to cancer and the ages at which they die due to diseases of the circulatory system. Base your answers to questions 15-19 on the information found in the graph.



[The solid line represents deaths due to circulatory diseases]
[The line with the dashes ( - - - ) shows deaths due to cancer]

15. In which age group did the highest percentage of deaths due to cancer occur?
    a. 25-44
    b. 45-64
    c. 65-74
    d. 75-84

16. How did the percentage of deaths due to cancer in the 15-24 age group compare to the percentage of deaths due to cancer for those who were 85 or older?
    a. Cancer is more of a threat in the younger age group.
    b. Cancer is more of a threat in the older age group.
    c. The percentage of deaths due to cancer is about the same for both.
    d. There is not enough information on the graph for an answer.

NAME______________________________________

17. What is true about cancer and circulatory disease as causes of death for those in the 25-44 age group?
    a. Both are about the same.
    b. Cancer is more likely to be the cause of death.
    c. Circulatory disease is more likely to be the cause of death.
    d. You can not make such a comparison from this graph.

18. What general pattern describes deaths due to these diseases for people who are 65 and older?
    a. Both diseases continue to increase as causes of death.
    b. Both diseases become less important as causes of death.
    c. Cancer tends to increase as a cause of death after age 65.
    d. Circulatory disease tends to increase as a cause of death.

19. In which one age group are deaths due to both cancer and circulatory disease most likely to occur?
    a. 25-44
    b. 45-64
    c. 65-74
    d. 75-84

20. Which one of the following does not belong in a list of infectious diseases?
    a. fever
    b. flu
    c. pneumonia
    d. common cold

21. Which one of the following does not belong in a list of noninfectious diseases?
    a. cancer
    b. tuberculosis
    c. diabetes
    d. heart disease

22. Most bacteria are:
    a. harmful
    b. helpful
    c. harmless
    d. germs

23. The blockage of coronary arteries by fatty deposits most directly affects the working of a person's:
    a. lungs
    b. liver
    c. brain
    d. heart

NAME________________________________________

24. Which one of the following groups of food would be most effective for a person who was trying to reduce the amount of cholesterol in the blood?
    a. lamb chops, butter, and whole milk
    b. ham, eggs, and french fries
    c. chicken, fish, and skim milk
    d. bacon, ice cream, and cheese

25. In recent years, some schools and public buildings have been temporarily closed while repairs were made to the ceilings. This was done to prevent asbestos from entering the air since there is evidence that exposure to this substance is directly related to:
    a. tuberculosis
    b. heart disease
    c. cancer
    d. diabetes

26. Under what circumstances would a patient be advised to have a biopsy?
    a. when a doctor suspects a tumor may be malignant
    b. when a patient is believed to be suffering from hypertension
    c. when a woman thinks that she is pregnant
    d. when a person is very much overweight

27. Which one of the following is not a condition necessary for bacterial growth?
    a. food
    b. warmth
    c. light
    d. moisture

28. Different types of bacteria can best be identified by their:
    a. shape
    b. color
    c. size
    d. numbers

29. Penicillin is an example of an:
    a. antiobiotic
    b. antiseptic
    c. antibody
    d. antigen

NAME________________________________________

30. What has been done to surgical instruments when they have been sterilized?
    a. The harmful bacteria have been destroyed but the harmless bacteria are still present.
    b. The harmful and the harmless bacteria have been destroyed.
    c. The harmless bacteria have been destroyed but the harmful bacteria are still present.
    d. Both the harmful and the harmless bacteria have been weakened but not destroyed.

31. Viruses are more difficult to stop with antibiotics than bacteria because the viruses:

    a. reproduce only inside cells
    b. are extremely tiny
    c. are immune
    d. form protective coats

32. Malaria is a disease which is caused by:
    a. mosquitoes
    b. microscopic animals
    c. bacteria
    d. viruses

33. Why are your skin, the tiny hair-like cilia in your nose and throat, and white blood cells so important?

    a. They help your body to transport and remove cell wastes.
    b. They are essential to the digestion of foods.
    c. They are a major part of your defenses.
    d. They make it possible for you to produce necessary vitamins.

## ANSWER KEY FOR THEME IV QUESTIONS

1. C
2. D
3. A
4. B
5. C

6. D
7. C
8. A
9. A
10. E

11. C
12. B
13. E
14. C
15. B

16. C
17. A
18. D
19. B
20. A

21. B
22. C
23. D
24. C
25. C

26. A
27. C
28. A
29. A
30. B

31. A
32. B
33. C

## GOVERNMENT AGENCIES FROM WHICH FREE INFORMATION MAY BE OBTAINED

### New York City Agencies

Bureau of Water Register
Municipal Building
New York, NY 10007

Bureau of Water Supply
1250 Broadway
New York, NY 10001
966-7500

Bureau of Water Pollution Control
20 Worth Street
New York, NY 10013

Department of Environmental Protection
2358 Municipal Building
New York, NY 10007
566-4124
Citizens' Complaints (966-7500)

Environmental Control Board
333 W. 34th Street
New York, NY 10001
971-3600

Bureau of Sewers
40 Worth Street
New York, NY 10013

### New York State Agencies

New York State Energy Research and Development Authority
Agency Building 2
Rockefeler Plaza
Albany NY 12223
(518) 465-6251

Department of Environmental Conservation
2 World Trade Center
New York, NY 10047
488-2788

### Federal Agencies

Environmental Protection Agency
401 M Street S.W.
Washington D.C. 20460
(202) 755-2670

NY Area
26 Federal Plaza
New York, NY 10278
264-2525

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National Geographic Educational Services
Department 82
Washington, DC 20036

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Saving Our Planet

Saving Our Land

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- Water II
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The Beer Can on the Highway

Acid Rain: The Choice is Ours

Voice of the Water

Soil: Its Meaning for Man

Energy Crisis: Waste, Indecision, and Indifference

From Granite to Soil

Water: Its Physical, Chemical, and Biological Properties

Water in the Air (set)

Evaporation: Where Does the Water Go?

Condensation: The Other Side of the Story

The Water Cycle: Completing the Picture

Humidity: The Degree of Moisture

Humidity: Measurements and Applications

**Science Software System**
**11899 W. Pico Blvd.**
**West Los Angeles, CA 90064**

The Water Cycle

- Pollution Ecology
    - The Hydrological Cycle
    - Air Pollution
    - Land Pollution
    - Water Pollution
    - Characteristics of the Atmosphere

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### THEME 3

Alley Pond Environmental Center
228-06 Northern Blvd.
Little Neck, NY 11363

American Museum of Natural History
Central Park West and 79th Street
New York, NY 10024
School Groups (873-7320)
General Information (873-1300)

Department of Sanitation
Public Information Office
125 Worth Street
New York, NY 10013
577-5527

National Maritime Historical Society
2 Fulton Street
Brooklyn, NY 11201

New York Aquarium
Boardwalk and W. 8th Street
Brooklyn, NY 11224
266-8624

U.S. Department of the Interior
National Park Service
Gateway National Recreational Area
Park Headquarters / Floyd Bennet Field
Brooklyn, NY 11224

# Evaluation Form

## NINTH GRADE GENERAL SCIENCE

Since *Ninth Grade General Science* is new and experimental, we need your suggestions and support so it can be revised into a more complete form during the 1984-85 academic year.

Please answer the questions below as completely as you can, assured that your reactions will be much appreciated and given most respectful consideration in compiling the revised edition. Please send your completed evaluations to:

Dr. Anthony A. Galitsis, Director of Science
Board of Education of the City of New York
Science Unit — Room 409
131 Livingston Street
Brooklyn, New York 11201

NAME: ____________________ SCHOOL: ____________________

SCHOOL ADDRESS: ____________________

NUMBER OF STUDENTS PILOTING COURSE: ____________________

ABILITY LEVEL OF STUDENTS: ____________________

1. Are the goals of this course of study clear? ☐ YES ☐ NO

Explain: ____________________

2. Does this curriculum meet your students' needs? ☐ YES ☐ NO

Explain: ____________________

3. Is the format of this course of study useful? ☐ YES ☐ NO

Explain: ____________________

4. Is this course of study well organized? ☐ YES ☐ NO

Explain: ______________________________

5. Would you make any changes in the types of learning activities presented in this course of study? ☐ YES ☐ NO

Explain: ______________________________

6. Did the suggested activities enable the students to achieve the performance objectives? ☐ YES ☐ NO

Explain: ______________________________

7. Did any of the suggested laboratory activities cause problems? ☐ YES ☐ NO

Explain: ______________________________

8. Do you think there will be any difficulty in implementing this course? ☐ YES ☐ NO

Explain: ______________________________

9. What additions, deletions, or changes in sequence would you recommend for each unit?

______________________________

10. What changes would you make to improve the quality of this document?

______________________________

11. Do you have any additional comments?

______________________________

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